Module Information
معلومات المادة الدراسية

Module Title	**BIOELECTROMAGNETIC FIELDS**	**Module Delivery**	
Module Type	BASIC	✓ **Theory** **Lecture** **Lab** **Tutorial** **Practical** **Seminar**	
Module Code	UOMU0101055		
ECTS Credits	5		
SWL (hr/sem)	125		
Module Level	UGIII	**Semester of Delivery**	5
Administering Department	Biomedical Engineering Dept.	**College**	College of Engineering
Module Leader	Ibrahim abdullah murdas	**e-mail**	ibrahim.abdullah.murdas@uomus.edu.iq
Module Leader's Acad. Title	Lecturer	**Module Leader's Qualification**	Ph.D.
Module Tutor	None	**e-mail**	None
Peer Reviewer Name		**e-mail**	
Review Committee Approval	2025\9\1	**Version Number**	

Relation With Other Modules
العلاقة مع المواد الدراسية الأخرى

Prerequisite module		**Semester**	Seven
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Aims أهداف المادة الدراسية	The central aim of this module is to understand how Maxwell unified electricity, magnetism and optics into electromagnetic theory. Knowledge of the basic phenomena of electromagnetism, and a good understanding of the mathematics of vector fields, are essential in achieving the central aim. Maxwell's four equations describe all of electromagnetism, including the propagation of electromagnetic waves. This module can be resumed by general points listed as:- 1. Vector calculus: gradient, divergence and curl operators, Gauss's theorem and Gauss's law, Laplace's and Poisson's equations. 2. Stationary electric flux field: current density, electric field strength and power density. 3. Static magnetic field: magnetic flux density, magnetic field strength, permeability, Ampere's law, Biot-Savart's law. 4. Magnetisation: diamagnetism, paramagnetism, ferromagnetism, hysteresis loop. 5. Electromagnetic induction: Faraday's law, energy in magnetic fields. 6. Maxwell’s equations (differential and integral form), wave equation. 7. Electromagnetic waves in free space and dielectric media. 8. Applications: signal transmission, electromagnets, bio-electromagnetism ,bioelectricity.
Module Learning Outcomes	

مخرجات التعلم للمادة الدراسية	1. To have detailed knowledge of the physical background and terminology of the electromagnetic field theory for electrical engineering problems. 2. To understand the electromagnetic field behavior. 3. To select and use appropriate theoretical models for analysis, problem solving and finding solutions related to the electrostatic, electrodynamics and electromagnetic fields. 4. To understand how laws of electromagnetism can be applied to problems arising in engineering and biomedical sciences. 5. To understand displacement current, Maxwell's equations and its related to time varying potential, time harmonic fields also study the plane wave in good conductor, Skin effect, Skin depth. 6. To understand the radio wave therapy, effects radio wave in human body, electromagnetic pollutions.
Indicative Contents المحتويات الإرشادية	The Cartesian coordinate system, vector components and unit, vector field, dot product, cross product, circular cylindrical coordinate system, spherical coordinate system ,coulombs law, electric field intensity – field of n point charges, field due to a continuous volume charge distribution , field of line charge [15 hrs]. Field of a sheet of charge, field of a volume of charge, streamlines and sketches of fields ,electric flux density, Gauss's law ,applications of Gauss's law, differential volume element ,energy expended in moving a point charge, potential difference and potential [15 hrs]. The potential field of a point charge, the potential field of a system of charges , ,potential gradient, the dipole, energy density in electrostatic field , current and current density, continuity of current, conductor properties and boundary conditions , method of images, dielectric materials and boundary conditions, capacitance, several capacitance examples of the solution of Laplace's equation,

	and examples of the solution of Poisson's equation [20 hrs]. Boit-Savart law, Ampere's circuital law, the curl, Stokes theorem, magnetic flux, magnetic flux density, the scalar and vector magnetic potentials, force on a moving charge, force on differential current element, and force between differential current elements Maxwell's equations derivations[10hrs]. Inductance and mutual inductance , Faraday's law ,displacement current, Maxwell's equations in point form, Maxwell's equations in integral form [15 hrs].
Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	Development and use of the point and integral forms of Maxwell's equations for static and quasi-static electric and magnetic fields with emphasis placed on the vector nature of these fields. Includes analytic and computational solutions to field's problems. The wave equation for E.M. fields is derived and discussed. Development and use of Wave Equations as derived from Maxwell's equations to explain the propagation of electromagnetic waves. Includes treatment of physicaloptics, radio-signal diagnosis and treatment ,antennas, wave-guides and transmission lines.

Student Workload (SWL) الحمل الدراسي للطالب			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	78	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	5
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	32	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	2
Total SWL (h/sem)	125		

الحمل الدراسي الكلي للطالب خلال الفصل	

Module Evaluation
تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	**Quizzes**	2	10% (10)	5, 10	LO #1, 2, 10 and 11
	Assignments	2	10% (10)	2, 12	LO # 3, 4, 6 and 7
	Projects / Lab.	1	10% (10)	Continuous	
	Report	1	10% (10)	13	LO # 5, 8 and 10
Summative assessment	**Midterm Exam**	2 hr	10% (10)	7	LO # 1-7
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)
المنهاج الأسبوعي النظري

	Material Covered
Week 1	Cartesian, cylindrical, and spherical coordinate systems
Week 2	Divergence, Gradient, Curl and Laplacian , Divergence and Stokes' theorems.
Week 3	Coulomb's Law, Electric field intensity Field due to continuous line, surface, and volume charges
Week 4	Electric flux density Gauss Law Energy expended in moving a charge in an electric field-Potential & potential gradient Electric Dipole.
Week 5	Current and Current Density, Resistance, Dipole moment Polarization- Properties & boundary conditions of metallic conductors, semiconductors and dielectrics, Laplace and Poison’s equations.

Week 6	Magnetization and permeability , magnetic boundary conditions ,the magnetic circuit , potential energy and forces on magnetic materials, human body magnetic effects and properties.
Week 7	Magnetic permeability (constant) ,Magnetizations ***M*** and Magnetic-field intensity ***H*** in linear magnetic media ,boundary conditions magnetic fields, energy density of magnetic field.
Week 8	Ampere-Law related to Maxwell equation.
Week 9	Derive Maxwell's first equation from Gauss' Flux Law of Electrostatics, using Gauss' theorem with applied examples.
Week 10	Derive Maxwell's first equation from Gauss' Flux Law of Electrostatics, using Gauss' theorem with applied examples.
Week 11	Maxwell's equations examples ,Energy density of an electromagnetic field ,the Poynting vector, effects radio wave in human body, electromagnetic pollutions.
Week 12	Wave propagation in dielectrics, Poynting vector and power considerations, propagation in good conductors, skin depth, phase velocity, wave polarization.
Week 13	Radio wave therapy, effects radio wave in human body, electromagnetic pollutions.
Week 14	Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation.
Week 15	**Preparatory Week**
Week 16	**Final Exam**

Learning and Teaching Resources
مصادر التعلم والتدريس

	Text	**Available in the Library?**
Required Texts	1-Engineering Electromagnatic, William H. Hayt, Jr. and John A. Buck, the McGraw-Hill Book Company, 2001.	Yes

	2- Element of Electromagnetic, Sadiku, Matthew N.O.,, Oxford University Pres, Inc., 2001. 3- Gottapu Sasibhushanarao. " Electromagnetic Field Theory and Transmission Lines" Wiley. 4- Electromagnetic with application, Krause, 5th Edition, TMH.2008.	
Recommended Texts	Bioelectromagnetism Principles and Applications of Bioelectric and Biomagnetic Fields , Jaakko Malmivuo and Robert Plonsey, Oxford University , Inc., 1995 .	No

APPENDIX:

GRADING SCHEME مخطط الدرجات				
Group	**Grade**	التقدير	**Marks (%)**	**Definition**
Success Group (50 - 100)	**A** - Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C - Good	جيد	70 - 79	Sound work with notable errors
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
	E - Sufficient	مقبول	50 - 59	Work meets minimum criteria
Fail Group (0 – 49)	**FX** – Fail	مقبول بقرار	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note:

NB Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.