ELE2211 ELECTROMAGNETIC FIELDS

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
45	30	00	60	100	60	40	4

[Pre-requisite: Course ELE2103]

Rationale

The course covers types and propagation of electromagnetic waves and their importance in electrical and telecommunications engineering.

Course Objectives

By the end of the course students should be able to:

- Derive relevant equations applied in wave guides and propagation of EM waves and understand their importance in the different electrical engineering fields
- Use electromagnetic laws and principles to solve problems in propagation of EM waves.

Detailed Course Content:

Unbounded Wave Propagation: **[17 Hours]**

Definition of wave motion; The wave equation in a perfect dielectric; Helmholtz equation. Uniform plane wave propagation; intrinsic impedance. Distinction between conductors, quasiconductors and dielectrics. Wave equation in a conductive medium; Attenuation and phase constants for good dielectrics and good conductors; Skin depth and surface impedance. Poynting's vector; Cases of perfect dielectric and conducting media. Reflection of uniform plane waves-normal incidence; Reflection and transmission coefficients; standing waves and VSWR; Energy in standing waves. Polarization: Definition of linear, circular and elliptic polarization.

Guided Waves and Wave Guiding Systems: **[18 Hours]**

Distinction between transmission lines and waveguides; Types of transmission lines and waveguides. Transmission line equation using distributed circuit analysis; Primary and Secondary constants (R, L, G, C, α, β, Zo) α,β,Zo for lossless and low loss lines ; Terminated lines: Expressions for voltage, current and impedance at any point; short circuited, and matched lines; Power flow on transmission lines, Parameters (primary and secondary) for coaxial and parallel wire transmission lines. Standing waves on transmission lines: Relationship between S and ρ, Standing wave patterns for different terminations. Matching: Necessity of matching; Matching devices-quantative treatment of quarter wave transformer, single stub and double stub tuners; Triple stub turner (qualitative treatment). The Smith Chart: Development and applications (Limited treatment). The infinite plane waveguide: Field expression starting from Maxwell's equations after separating solutions into TE, TM and TEM modes; Field patterns; Concept of cut-off frequency; Definition and inter-relationship between free space wavelength, guide wavelength, cut-off wavelength, space velocity and group velocity; Attenuation and qualitative introduction to perturbation analysis for attenuation; impedance conventions.

Hollow rectangular waveguide: **[10 Hours]**

Derivation of complete field expressions for TM and TE modes starting with Maxwell's equations and the wave equations; Expressions for α, β, f_c: Field patterns; The dominant mode and its parameters; Circular waveguide: Field solutions for TE and TM modes. Microstrip Transmission lines: characteristics and empirical expressions. Wave propagation in plasmas: Plasmas oscillations; Plasma frequency; Maxwell equations; Concept of plasma cut-off frequency and consequences. Optical fibres: Qualitative discussion of electromagnetic modes in fibres; Discussion from a physical optics point of view; Types of fibres; parameters.

Introduction to numerical Electromagnetics: Overview of the numerical/computational methods applied in electromagnetic problems

Mode of Delivery

The course will be taught by using lectures, tutorials and assignments.

Assessment

Assignments, tests, laboratories and final examination. Their relative contributions to the final grade are :

Requirement	**Percentage contribution**
Course work (Assignments, laboratories, tests)	40%
Final examination	60%
Total	**100%**

Learning Outcomes

By the end of this course, students should be able to:

- Demonstrate a firm understanding of electromagnetic fields
- Solve realistic electromagnetic-field problems utilizing physical conceptual reasoning and mathematical synthesis of solutions, and not pure formulaic solving.

Method of Teaching /Delivery

The course will be taught by using lectures, tutorials and assignments.

Mode of Assessment

Assignments, tests and final examination. Their relative contributions to the final grade are :

Requirement	**Percentage contribution**
Course work (Assignments, tests)	40
% Final examination	60
% **Total**	**100%**

Recommended and Reference Books

[1] K. Lonngren, S. Savov, & R. Jost, *Fundamentals of Electromagnetics with MATLAB,* 2nd Edition (Scitech Publishing, 2007).

[2] R. Wolfson & J. Pasachoff, *Physics for Scientists and Engineers* (Addison-Wesley).

[3] J. Stewart, *Calculus*, Third Edition (Brooks/Cole Publishing Company, 1995).

[4] N. N. Rao, "*Elements of Engineering Electromagnetics*," 6th Edition, Prentice Hall, 2004.

[5] *Field and Waves in Communication Electronics,* third edition, Ramo, Whinnery, and Van Duzer, Wiley, 1994

[6] William H. Hayt, Jr. John A. Buck, 2000. *Engineering Electromagnetics*. 6th Edition MC Graw Hill.

[7] Mathew N.O. Sadiku, 2006. *Elements of Electromagnetics*, 4th Edition. ISBN 13: 9780195300482, ISBN 10:0195300483

Possible Lecturers:

Dr. E. Lugujjo
Mr. S. Mwanje
Mr. A Wasswa Matovu
Mr. P. Bogere
Mr. I. Kitone