EE-208-F:
Fundamentals of Electromagnetics

Introductory Concepts, Vector Fields and Coordinate Systems

Why Study Electromagnetics?

Electromagnetics is everywhere !

Electromagnetics is fundamental to the advancement of electrical and computer engineering technology !

Objective:

Introduce the basic principles of the electromagnetic phenomena in terms of a few relatively simple laws

Outcome:

Students are well-equipped:

to handle important practical problems in electrical & computer eng.,

to gain physical intuition about nature around themselves.

Why is Electromagnetics Difficult?

Electric and Magnetic Fields:

- are 3-dimensional !
- are vectors !
- vary in space and as well as time!
- are governed by **PDEs** (partial differential equations)

Therefore →

Solution of electromagnetic problems requires a high level of abstract thinking !

Students must develop a deep physical understanding !

Math is just a powerful tool !

What is Electromagnetics?

What is the basis of electromagnetics ? **CHARGE**

Electromagnetics is the study of **CHARGES**

The subject electromagnetics may be divided into 3 branches:

Electrostatics : charges are at rest (no time-variation)

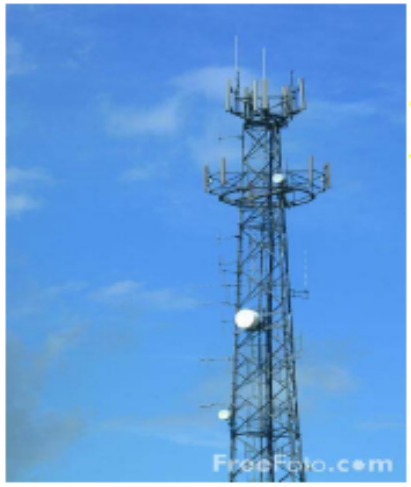
Magnetostatics : charges are in steady-motion (no time-variation)

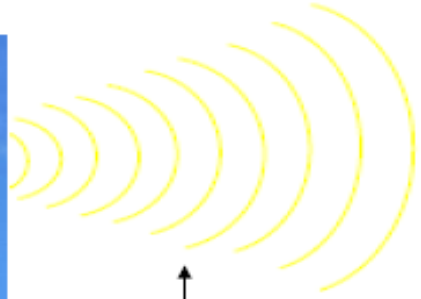
Electrodynamics : charges are in time-varying motion

(give rise to **waves** that propagate and carry energy and information)

Examples of Electromagnetic Applications

Communication Technology





Electromagnetic field

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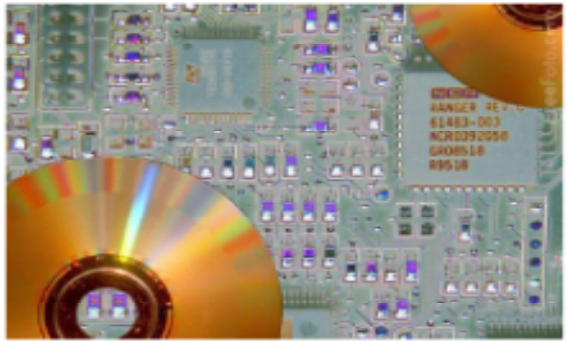
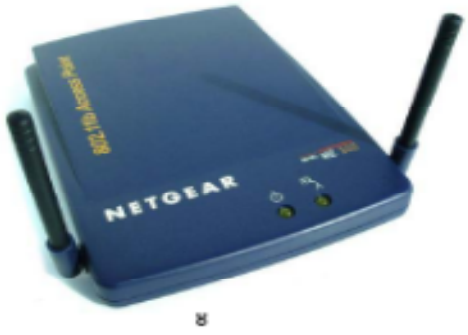
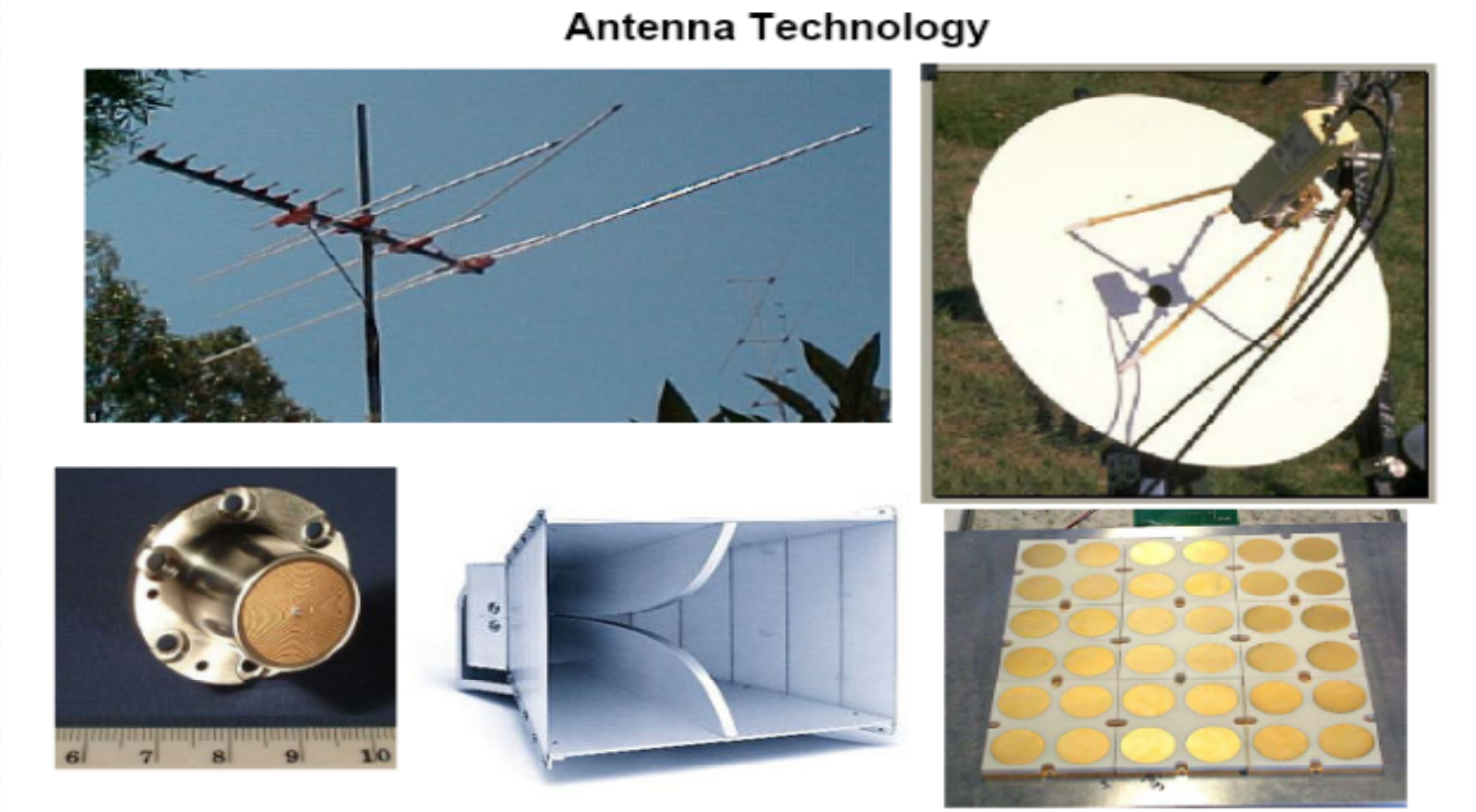
Examples of Electromagnetic Applications, Cont'd

Computer Technology



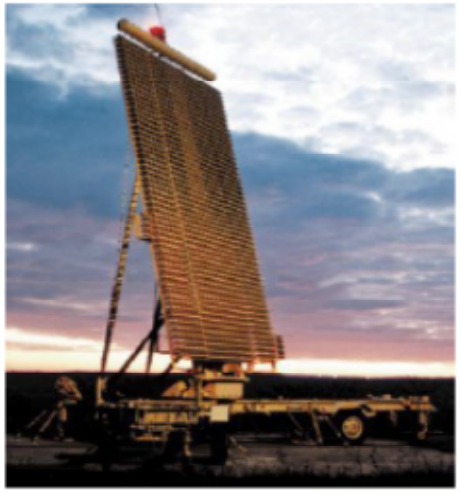


Examples of Electromagnetic Applications, Cont'd

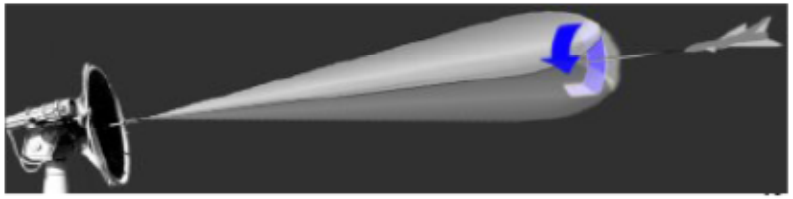


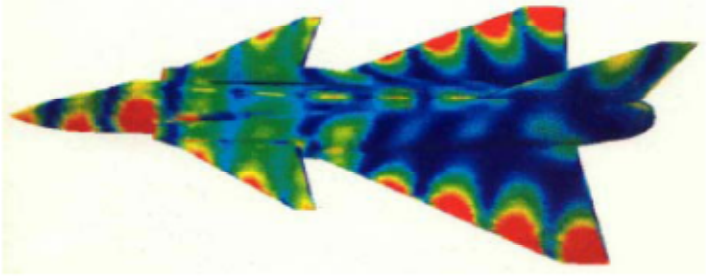
Examples of Electromagnetic Applications, Cont'd

Military Defense Applications



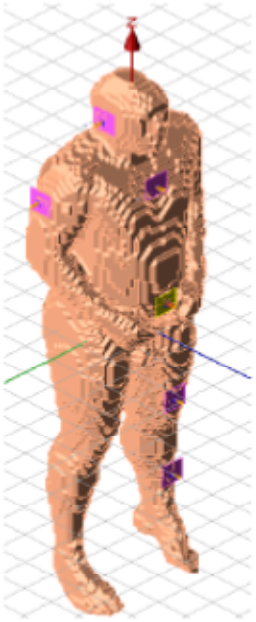
Radars

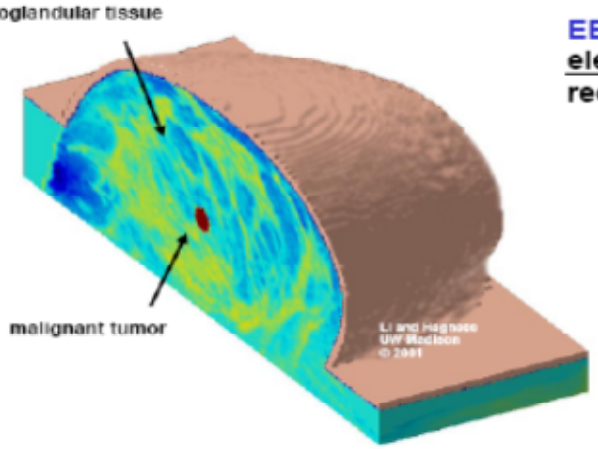




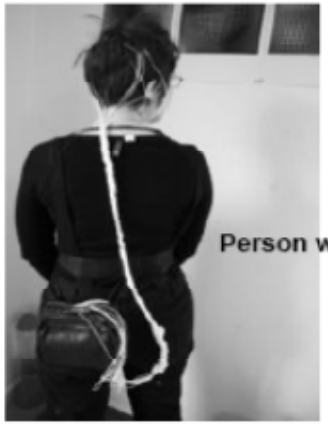
Examples of Electromagnetic Applications, Cont'd

Biomedical Applications





EEG (Electroencephalography) measures the electrical activity produced by the brain as recorded from electrodes placed on the scalp.



Person wearing electrodes for EEG

ECG (electrocardiogram) records the electrical activity of the heart over time.

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Research Areas of Electromagnetics

- Antenas
- Microwaves
- Computational Electromagnetics
- Electromagnetic Scattering
- Electromagnetic Propagation
- Radars
- Optics
- etc ...