

B38EM Introduction to Electricity and Magnetism

Lecture 1

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Topics

- Electric charges at rest (electrostatics)
- Steady electric current – electrons in motion
- Magnetostatics fields
- Electromagnetic induction

These four topics are known collectively as
‘Electromagnetism’

High frequency electromagnetics / microwaves
Wireless communications



References & Resources

- Elements of Electromagnetics (7th Edition), by Sadiku, Oxford University Press
- Fundamentals of Applied Electromagnetics (7th Edition), by Ulaby and Ravaioli
- Field and Wave Electromagnetics (2nd Edition), by David K. Cheng
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Electrostatics

electric field, potential diff.,
capacitance, charge

Magnetostatics

magnetic field, current,
inductance, magnetism

Electromagnetics

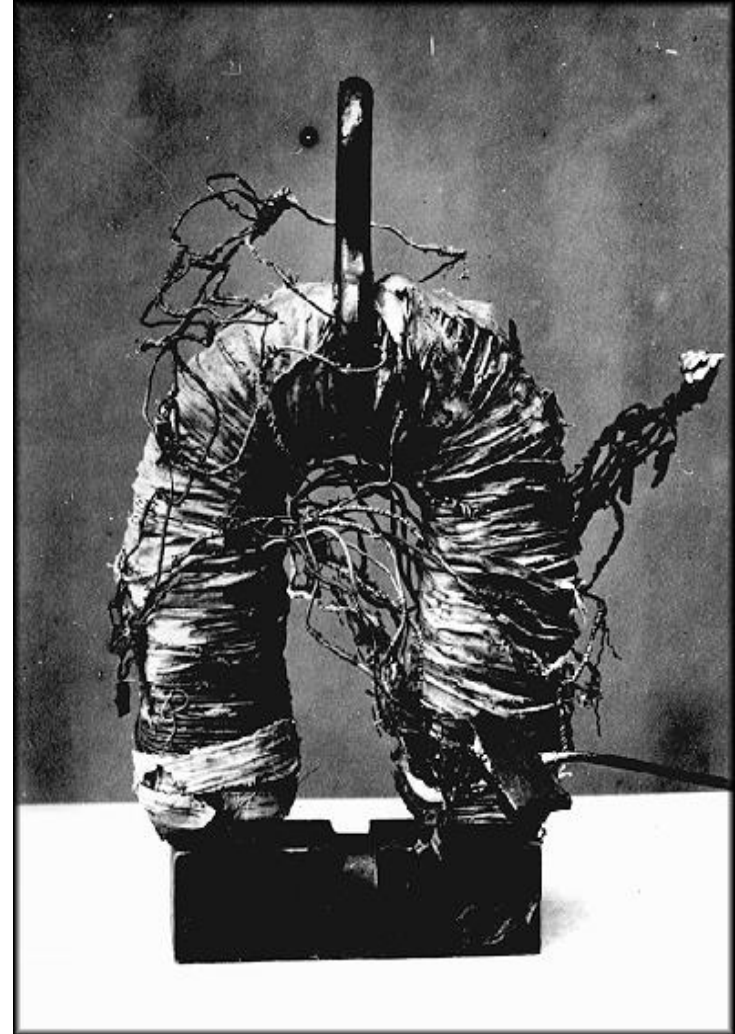
induction, emf, radiation,
EM wave



Electrostatics



Magnetostatics



Electromagnetics



EM Spectrum

$$c = \lambda f$$

FM radio: 88-108MHz

AM radio: 150-1600kHz

Power supply: 50-60Hz

CLASS	FREQUENCY	WAVELENGTH
Y	300 EHz	1 pm
HX	30 EHz	10 pm
SX	3 EHz	100 pm
EUV	300 PHz	1 nm
NUV	30 PHz	10 nm
	3 PHz	100 nm
NIR	300 THz	1 μm
MIR	30 THz	10 μm
FIR	3 THz	100 μm
EHF	300 GHz	1 mm
SHF	30 GHz	1 cm
UHF	3 GHz	1 dm
VHF	300 MHz	1 m
HF	30 MHz	10 m
MF	3 MHz	100 m
LF	300 kHz	1 km
VLF	30 kHz	10 km
VF/ULF	3 kHz	100 km
ELF	300 Hz	1 Mm
	30 Hz	10 Mm
	3 Hz	100 Mm

Major Applications

- Power generation / transmission (1882)
- Communications – wire / broadcast (1884)
- Electronics (1904) Vacuum Tube
- Radar (1940s)
- Computing and Control (1945)
- The transistor (1950s)
- Integrated circuits (1960s)
- Microprocessors (1980s)
- Mobile communications and the Internet (1990s)
- Microwave ovens, wireless power transmission, biomedical applications,



Later in your studies

This course forms a basis for subsequent modules

- transformers, machines, motors, generators
- transmission lines (microstrip, coax, stripline)
- fields and waves
- radar, wireless-communication
- electromagnetic interference, EMI
- electromagnetic compatibility, EMC
- microwave passive devices,
 - antennas, couplers, filters, splitters
- microwave active devices,
 - amplifiers, mixers, detectors MMIC, RFIC

Generator & Motor

Generator

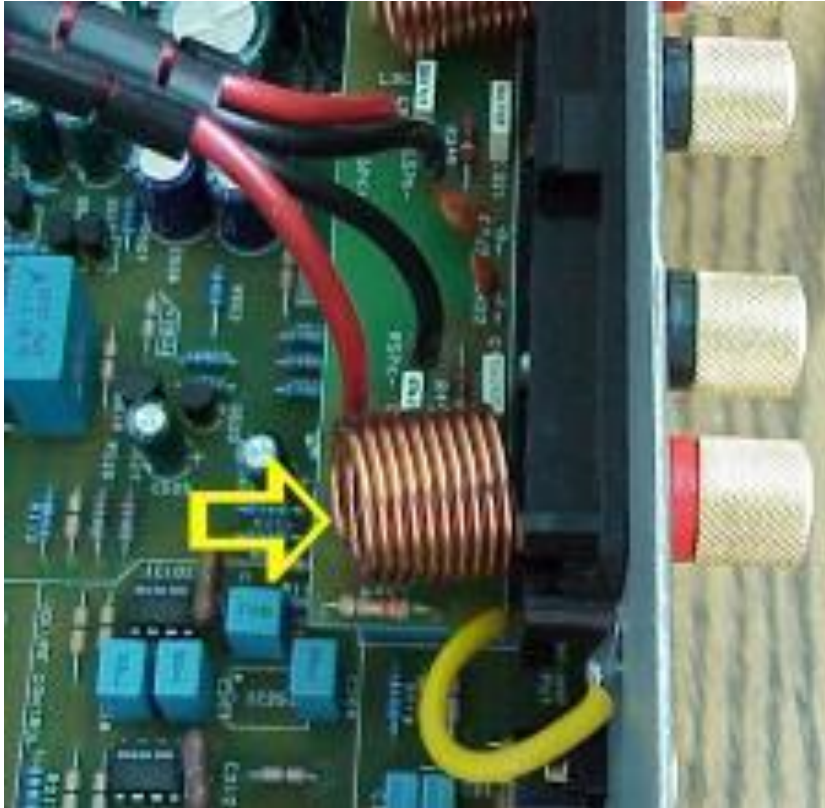


Motor

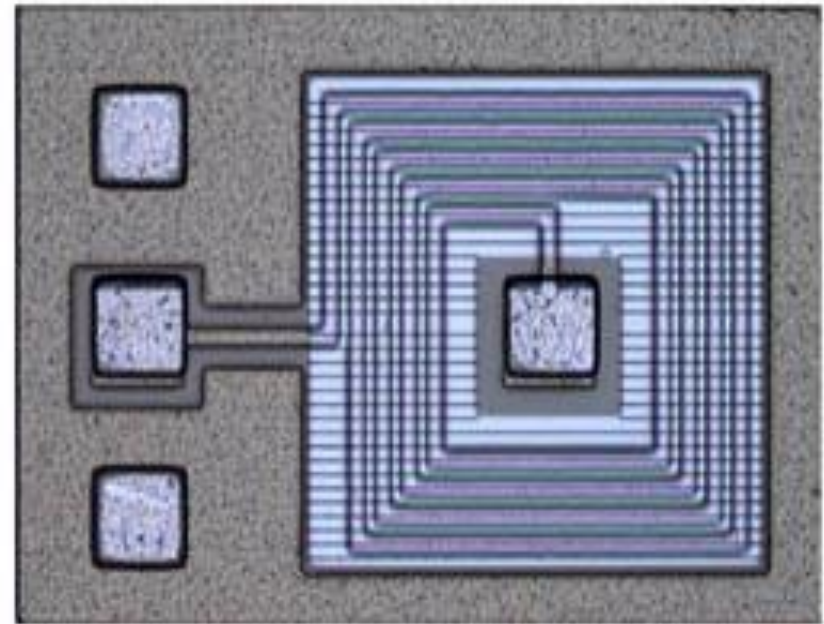


Electronics & Microelectronics

circuit inductor



on-wafer inductor



100μm



comparable size
to circuit opposite

Wireless Communications



What causes what?

- Bodies of stationary and isolated electric **charges produce electric fields** between them, but no magnetic field.
- A **current** carrying conductor will **produce a magnetic field** around itself, but no average electric field.
- A **time-varying electric current** will produce both magnetic and electric fields, this is better known as an **electromagnetic field**.

system of charges	electric field
direct current carrying conductor	magnetic field
alternating current carrying conductor	electromagnetic field

Assessment Plan

50% Two time-limited in-class Examinations

50% Assignments & Computer labs