

EE 3113

INTRODUCTION INTO RF

CIRCUIT DESIGN

Lecture Notes for A-term 1999

LECTURE 2

Prof. R. Ludwig

Department of Electrical and Computer Engineering

Worcester Polytechnic Institute

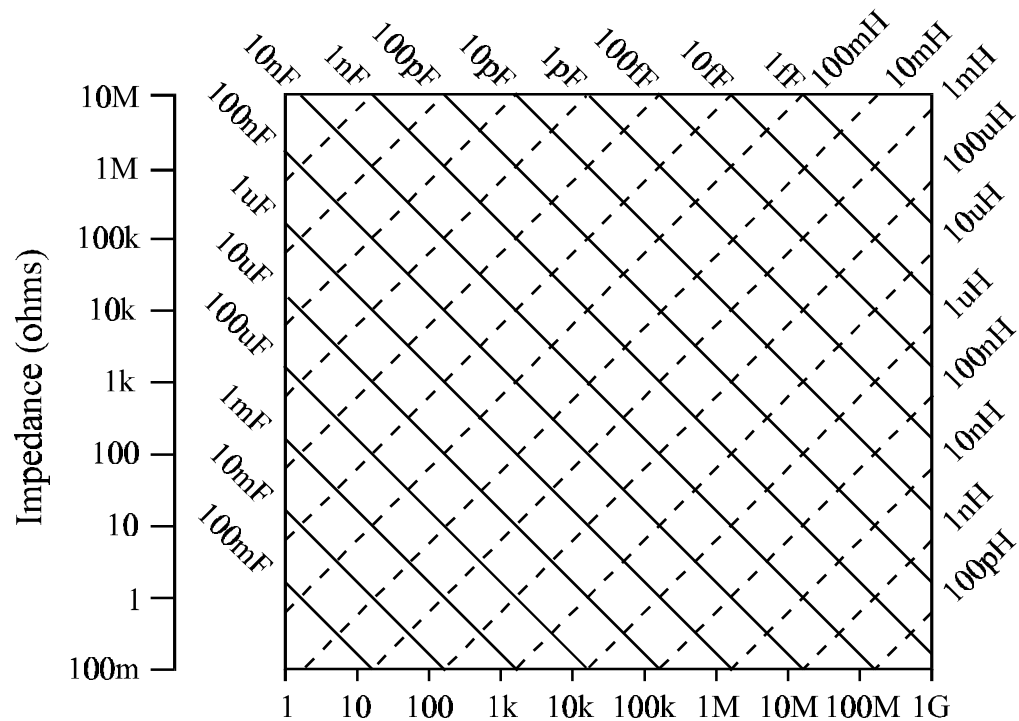
Worcester, MA

RF Behavior of Passive Components

- Conventional circuit analysis
 - R is frequency independent
 - Ideal inductor: $X_L = j\omega L$
 - Ideal capacitor: $X_C = 1/j\omega C$
- **Evaluation**
 - Impedance chart

Impedance Chart

(impedance of C & L vs frequency)

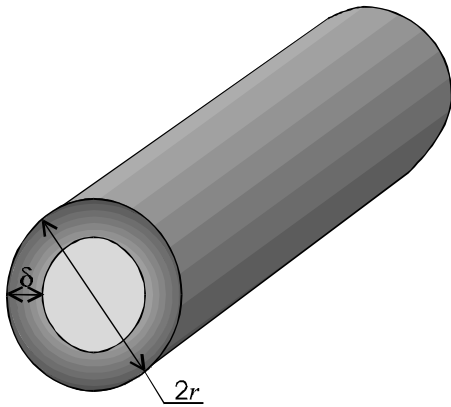


$$Z_C = 1/(2\pi fC)$$

$$Z_L = 2\pi fL$$

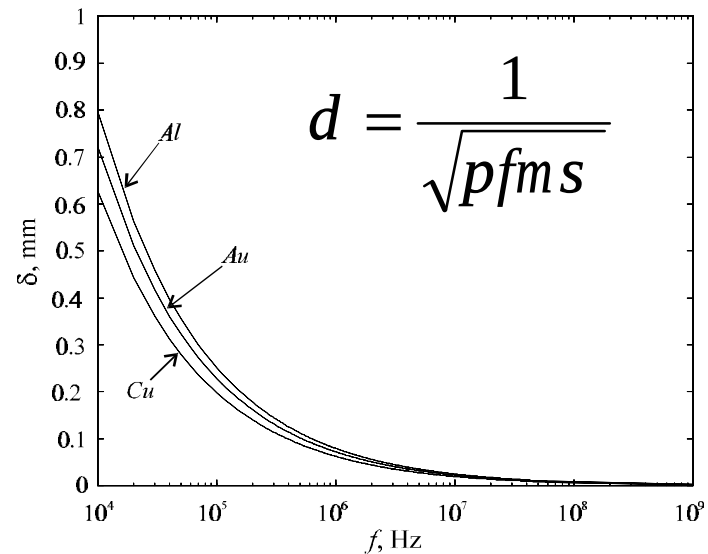
How does a wire behave at high frequency?

- Example: **Resistor**

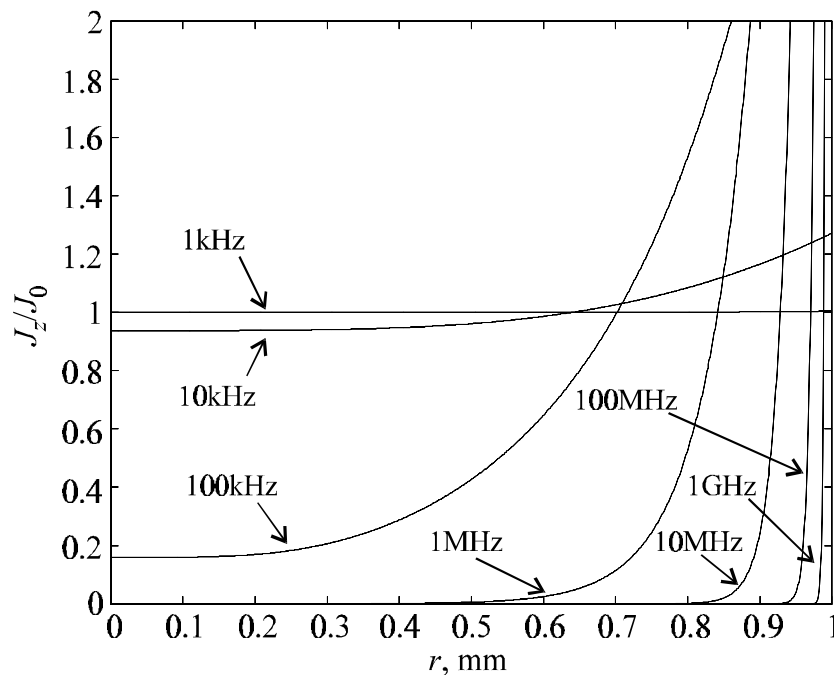


High frequency results in skin-effect whereby current flow is pushed to the outside

$$R_{DC} = \frac{l}{pa^2s}$$
$$R / R_{DC} = \frac{a}{2d}$$
$$wL / R_{DC} = \frac{a}{2d}$$



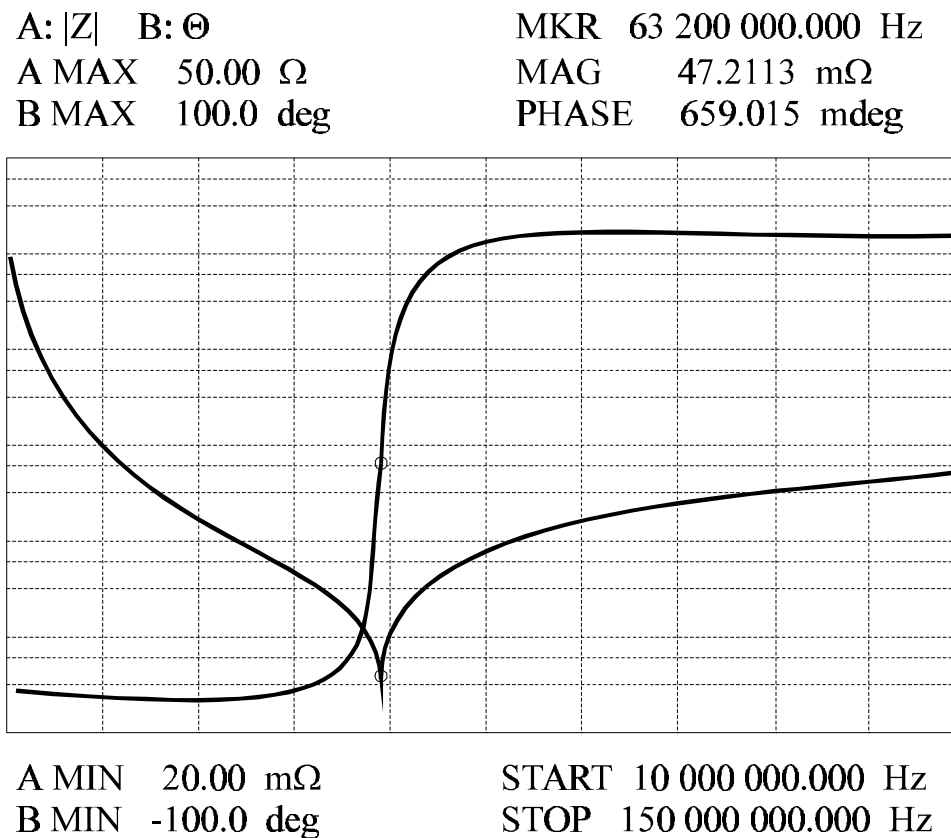
How exactly is the current distribution as a function of frequency?



- Low frequency shows uniform current distribution
- medium to high frequency pushes current to the outside
- RF “sees” current completely restricted to surface

Impedance Measurement Example

Capacitor going through resonance

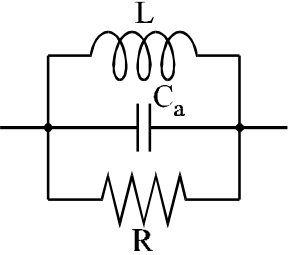
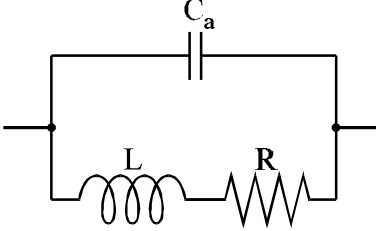
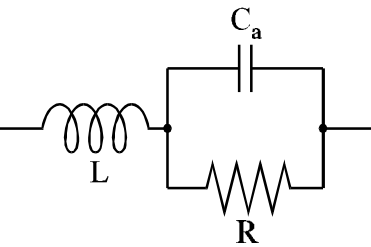
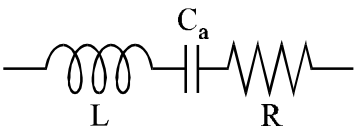
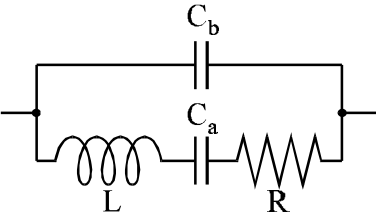


Capacitor
Characteristics

Equivalent Circuit Analysis

EQUIVALENT CIRCUIT MODEL

Selected : D

A (inductor)	B (inductor)	C (resistor)
		
D (capacitor)	E (crystal resonator)	
		

EQV R 38.6346 mΩ

EQV L 2.19795 nH

EQV C_a 82.1028 nF

EQV C_b F