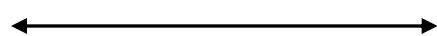
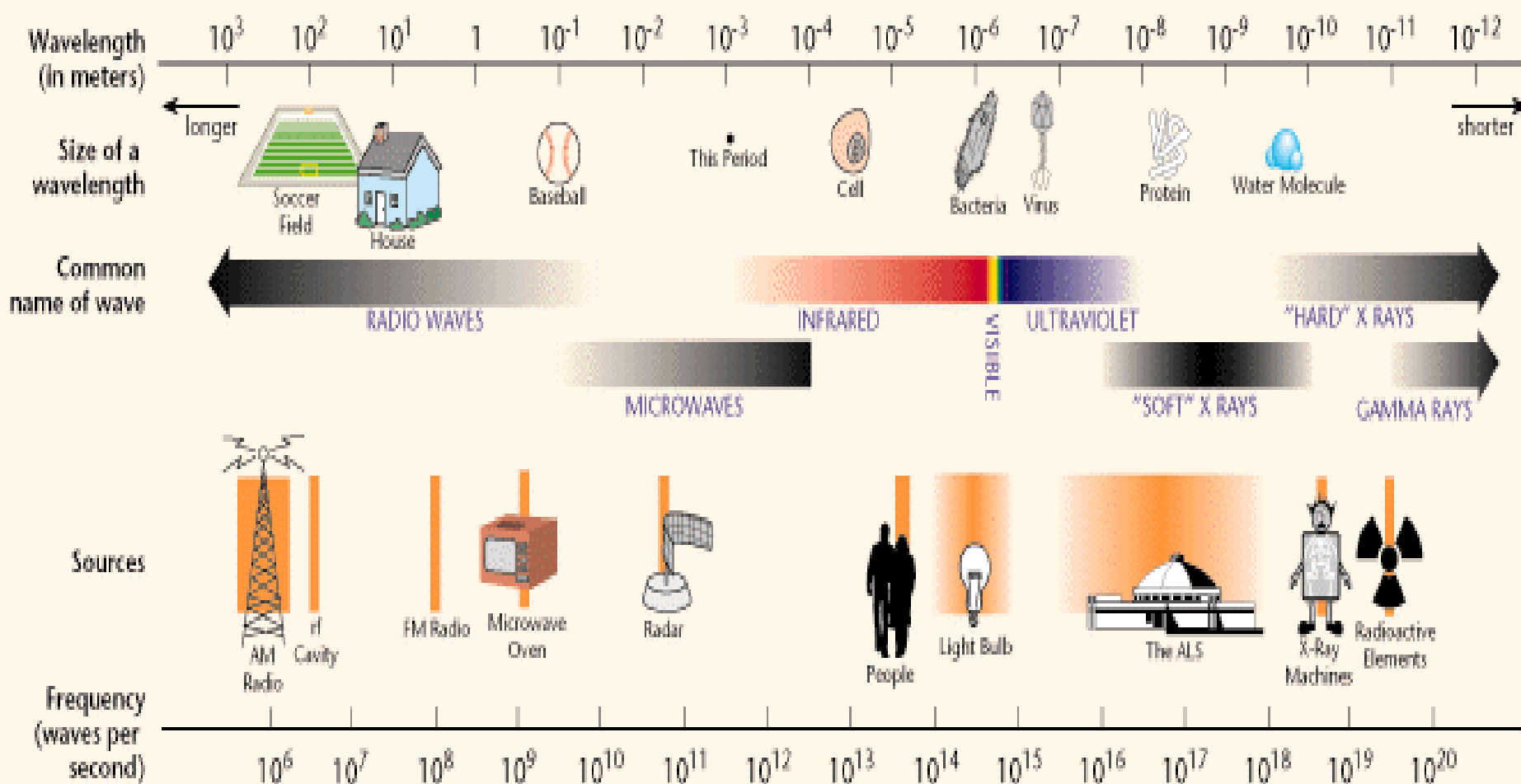


Introduction to Microwave Engineering

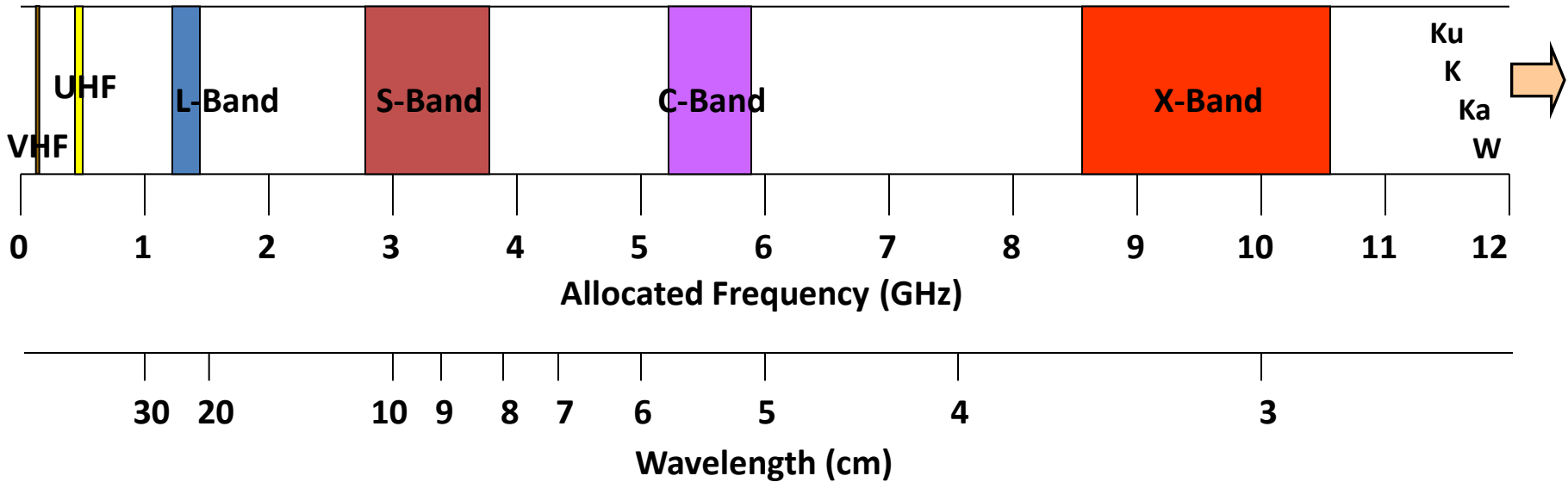
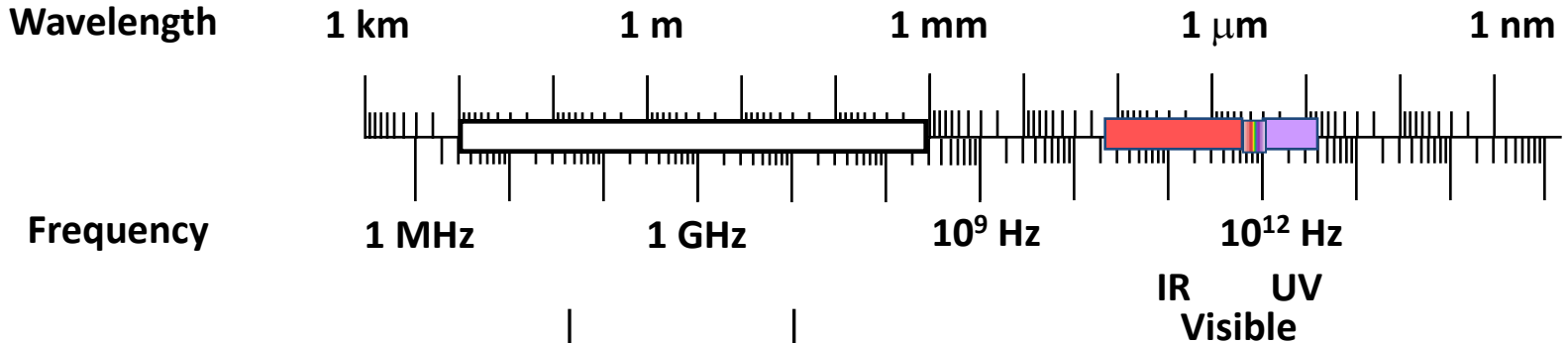
- Microwaves: 300 MHz ~ 300 GHz ($1 \text{ mm} \leq \lambda \leq 1 \text{ m}$)
- $1\text{mm} \leq \lambda \leq 10\text{mm} \rightarrow$ Millimeter waves
- Because of the high frequency (short wavelength), standard circuit theory generally cannot be used directly to solve microwave network problems.
- Microwave components: distributed elements (the phase of a voltage or current changes significantly over the physical extent of the device).

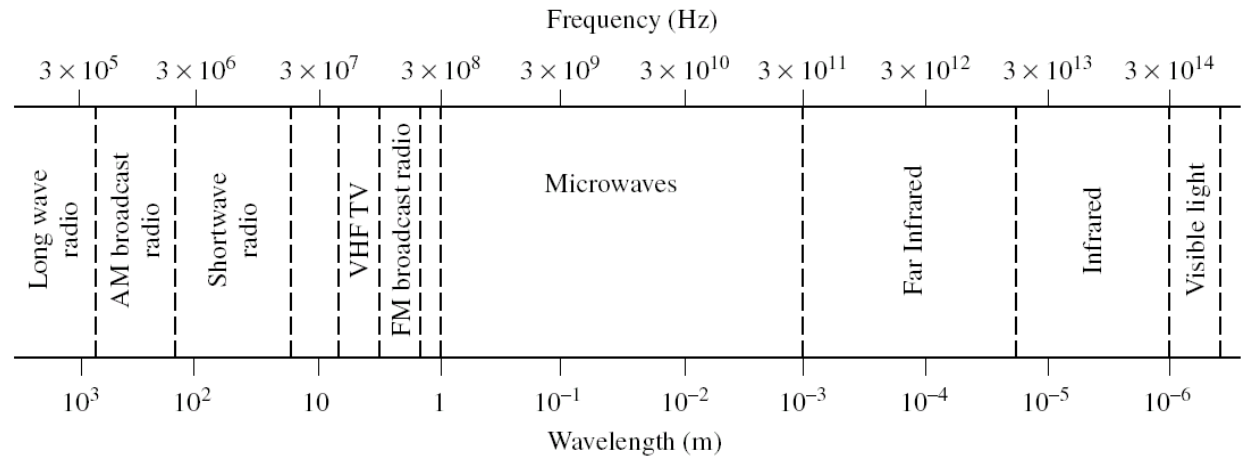
THE ELECTROMAGNETIC SPECTRUM



Radar Frequencies

Radar Frequency Bands





Typical Frequencies

AM broadcast band	535–1605 kHz
Short wave radio band	3–30 MHz
FM broadcast band	88–108 MHz
VHF TV (2–4)	54–72 MHz
VHF TV (5–6)	76–88 MHz
UHF TV (7–13)	174–216 MHz
UHF TV (14–83)	470–890 MHz
US cellular telephone	824–849 MHz
	869–894 MHz
European GSM cellular	880–915 MHz
	925–960 MHz
GPS	1575.42 MHz
	1227.60 MHz
Microwave ovens	2.45 GHz
US DBS	11.7–12.5 GHz
US ISM bands	902–928 MHz
	2.400–2.484 GHz
	5.725–5.850 GHz
US UWB radio	3.1–10.6 GHz

Approximate Band Designations

Medium frequency	300 kHz to 3 MHz
High frequency (HF)	3 MHz to 30 MHz
Very high frequency (VHF)	30 MHz to 300 MHz
Ultra high frequency (UHF)	300 MHz to 3 GHz
L band	1–2 GHz
S band	2–4 GHz
C band	4–8 GHz
X band	8–12 GHz
Ku band	12–18 GHz
K band	18–26 GHz
Ka band	26–40 GHz
U band	40–60 GHz
V band	50–75 GHz
E band	60–90 GHz
W band	75–110 GHz
F band	90–140 GHz

- Microwave Applications
 - Communication systems
 - Radar systems
 - Remote sensing
 - Medical systems