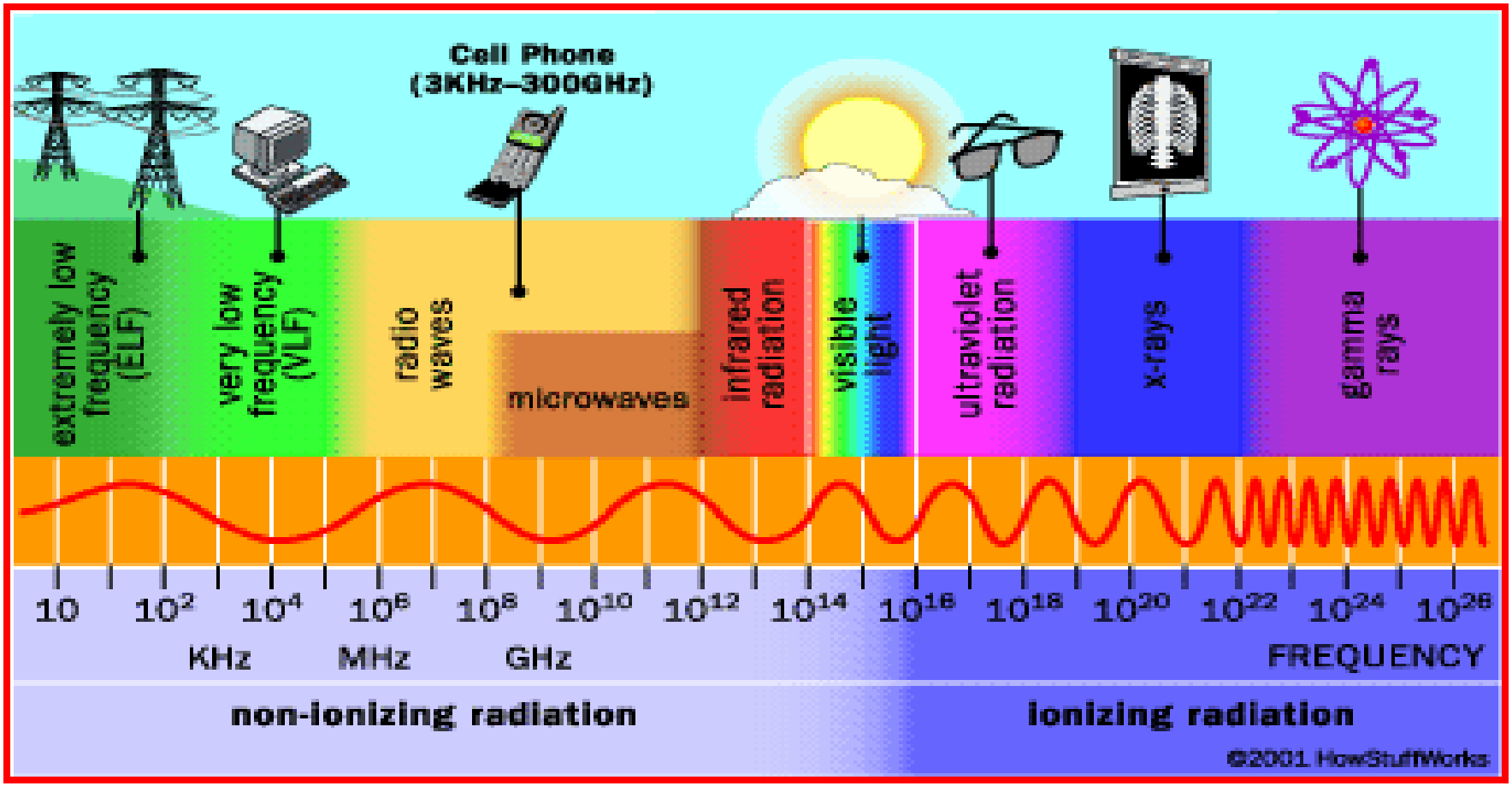
Microwave Engineering

Unit-3

Biological effects of microwaves

- Electromagnetic radiation in the 1 mm to 1 m wavelength range (300 MHz to 300 Ghz) is referred to as microwave radiation.
- A part of which is known as radiofrequency (RF) radiation, which covers 0.5 MHz to 300 GHz range and is considered in the context of adverse biological effects.

Ionizing and non – ionizing radiations of electromagnetic energy



Ionizing radiation

- Ionization is a process by which electrons are stripped from atoms and molecules and this can produce molecular changes that can lead to damage in biological tissue, including effects on DNA, the genetic material.
- This process requires interaction with high levels of electromagnetic energy to ionize biological material, this include X-radiation and gamma radiation.
- The energy levels associated with RF and microwave radiations are not great enough to cause the ionization of atoms and molecules, therefore, it is a type of non-ionizing radiation.

Non ionizing radiation

- Microwave energy is non-ionizing electromagnetic radiation.
- Ionizing radiation messes up molecules, non-ionizing radiation merely heats them.
- In general, it does not have sufficient energy to kick an electron off an atom thus producing charged particle in a body and cause biological damage.
- The only proven harmful effect from exposure to microwave (or RF) radiation is thermal.
- RF radiation can enter deep into the body and heat human organs.

Effect of microwaves in human body

- The blood vessels are dilating and the blood flow increases substantially as the thermoregulatory mechanism is activated in order to keep the body temperature constant.

- With rising body temperature the metabolic rate rises, which may lead to Stress-Adaptation-Fatigue Syndrome.

Effects produced by the electromagnetic waves at different frequency level

- Above 10 GHz (3 cm wavelength or less) heating occurs mainly in the outer skin surface.
- From 3 GHz to 10 GHz (10 cm to 3 cm) the penetration is deeper and heating higher
- .From 150 MHz to about 1 GHz (200 cm to 25 cm wavelength), penetration is even deeper and because of high absorption, deep body heating can occur.
- Any part of the body that cannot dissipate heat efficiently or is heat sensitive may be damaged by microwave radiation of sufficient power.

Measurement of Microwave exposure

- The microwave energy exposure is measured in terms of SAR (Specific Absorption Rate) or PD (Power Density).
- SAR is the energy which is absorbed in a unit of mass or volume of the body per unit time.
- The standards that limit microwave exposure were set at 0.4 W/kg SAR for occupational and 0.08W/Kg for public exposure.
- The averaging time for determination of SAR was 6 minutes. Power density is the energy absorbed per unit area in unit time. The high power microwaves definitely cause some adverse effects in the human system

Effects of Microwave energy

Power level (mW /cm2)	Long-term effect on human body	Remarks
0.01	Nothing	
0.1	Nothing	
1	Nothing	
5	Nothing	Accepted standard for microwave oven leakage
10	Nothing	Accepted standard for maximum continuous exposure to radiated emissions (cell phones, etc.)
30	You can feel heat	
100	Cataracts can be produced	Summer sunlight is at this level
1000	Pain is induced	