IT-771 : Electromagnetics applications for Biology (credit 04)

Advance research in electromagnetic theory has been a fundamental key driver to push the frontiers of biomedical technology. These studies include evaluation of health hazards of microwave field emission by ubiquitous wireless communication systems, interaction of electromagnetic waves with biological tissues and living systems, and also the therapeutic, diagnostic, and imaging applications of electromagnetics. Cancer detection using ultra-wideband signal, hyperthermia of tumors, healthcare informatics, and wireless bio implants are some of the research topics using electromagnetic waves.

Contents:

1. Review of Electromagnetic:

Fundamental properties of electromagnetic fields, Electric Field and Flux Density, Magnetic Field and Flux Density;

Mathematical description of electromagnetic fields: Maxwell's Equations: Gauss law, Faraday's law, Displacement current, Ampere's law; Time varying potentials: scalar and vector potentials; Electromagnetic Waves, Antennas and Near Field; Antennas: Fundamentals, Antenna Configurations, examples: Electric Dipole

2. RF/Microwave Interactionsin Biological Materials:

Penetration in Biological Tissues and Skin Effect;

Dielectric Measurements: RF Measurements, Microwave Measurements, Liquids, Applicators; Exposure;

Tissue Characterization: Ionization and Non-ionization, Dielectric Characterization: Dipolar Orientation, Interfacial Relaxation, Ionic Diffusion: Counter ion Polarization Effects;

Dielectric Dispersion in Tissues: Conductivity, Permittivity, Measurements: Tissues, Liquids Biological Effects: Absorption: Fundamentals, Dosimetry and SAR, Thermal Considerations; Radiation Hazards and Exposure Standards, Standards and Recommendations; Tissue Phantoms and SAR Measurements, Computational Methods for SAR Evaluation, Exposure of Body to Cell Phone and Base Station.

3. RE/Microwave Delivery Systems for Therapeutic Applications

Introduction, Transmission Lines and Waveguides for Medical Applications:

Skin Effect, Example: Coaxial Cable for Microwave Balloon Angioplasty Microwave Measurement Techniques Examples: Method of Measuring Blood Perfusion (Flow) inHeart Muscle by Use of Microwave Energy; Lumen Measurement of Arteries Utilizing Microwave Apparatus.

4. Wireless Body Area networks:

Introduction to Wireless Sensor Networks, patient monitoring; Technical Challenges Facing wireless BAN and personalized healthcare;

Wireless biotelemetry: inductive coupling and RF communication in body; antenna design and testing for BAN/BSN;

Matching networks and tuning: RF Losses in Components and Layout Issues, parasitic effects;

Power consideration and battery challenges;

BAN Application Scenarios: stand-alone and global healthcare system, pervasive sensor networks;

WBAN/WPAN network technologies overview, regulatory environments and IEEE regulatory standards; Healthcare System Integration.

Suggested readings:

- Vorst, A. Rosen, Y. Kotsuka, "RF/Microwave Interaction with Biological Tissues", Wiley (2006)
- F. Barnes, B. Greenebaum, "Bioengineering and Biophysical Aspects of Electromagnetic Fields", CRC (2006)
- S. Grimnes, 0. Martinsen, "Bioelectricity and Bioimpedance Basics", Academic Press (2008)
- Body Sensor Networks, Guang-Zhong Yang (Ed.), Springer-Verlag London Limited 2006, ISBN-13: 978-1-84628-272-0