Course Unit Descriptor

Study Programme: Biomedical engineering

Course Unit Title: Application of RF and microwaves in medicine

Course Unit Code: BMI108

Name of Lecturer(s): Sekulić Dalibor, Gajdobranski Đorđe

Type and Level of Studies: Bachelor

Course Status (compulsory/elective): compulsory

Semester (winter/ summer): winter

Language of instruction: english

Mode of course unit delivery (face-to-face/distance learning): face-to-face

Number of ECTS Allocated: 5

Prerequisites: none

Course Aims:.

Students will acquire fundamental knowledge in the field of radio and microwave propagation, as well as interaction mechanisms of radio and microwaves with biological tissues. They will be familiar with radio and microwave applications for diagnostic and therapeutic purposes. Training students for understanding the principles of operation and design of passive microwave components and circuits used in modern medical devices.

Learning Outcomes:

Fundamental theoretical knowledge about the propagation of radio and microwaves through human tissue and their interaction mechanisms which are used in diagnostic and therapeutic purposes. Capability to understand principles of operation, potentials and limitations of microwave components and circuits used in the modern medical devices, as well as in the state of the art and next generation of wireless systems (5G).

Syllabus.

Electromagnetic spectrum. Classification of radio and microwaves. Electromagnetic radiation and human health. Maxwell's theory of electromagnetic waves in the time and complex (frequency) domains. Propagation of electromagnetic waves in lossless and lossy media (propagation constant, attenuation constant, wave impedance, skin depth). TEM, TM, TE and hybrid waves. Energy and power. Poynting vector. Specific absorption rate–SAR. Polarization of electromagnetic waves. Reflection and transmission. Standing electromagnetic wave. Phenomena of resonance. Basics of resonant circuits (series and parallel resonant circuits, unloaded and loaded quality factors, half power bandwidth). Transmission lines (telegrapher's equations, propagation constant, characteristic and input impedances, standing wave ratio–SWR, phase and group velocity). Lossless transmission lines. Distortionless transmission lines. Quarter wave impedance transformer. Junction of two transmission lines with different characteristic impedances (return loss and insertion loss). Generator matched to loaded line for maximum power transfer. Conjugate matching. Coaxial transmission line. Planar transmission lines (microstrip and stripline). Waveguides. Basic theory of receiving and transmitting antennas. Medical applications of microwave antennas. Properties of tissues at RF and microwave frequencies. Dielectric spectroscopy of tissue. Interaction mechanisms of radio and microwaves with biological tissues. Bioheat equation. Application of microwaves in medical diagnostics. Therapeutic applications of heating effect of radio and microwaves. Shortwave and microwave diathermy (application in rheumatology and sports medicine). Hyperthermia. Radiofrequency and microwave ablation (application in oncology, cardiosurgery and urology).

Required Reading:

Weekly Contact Hours: 2	**Lectures: 3**	**Practical work: 2**

Teaching Methods:

Lectures. Auditory practices. Consultations

Knowledge Assessment (maximum of 100 points):

Pre-exam obligations	points	**Final exam**	points
Attendance			
Computer exercises			

Tests (4x)			