# Abstract

Over the last two decades, the popularity of medical bio-telemetry devices has increased interest in therapeutic and diagnostic features for continuous patient monitoring in applications such as temperature, heartbeat, glucose level detection, heart rate management, and so on. Implantable antennas integrated in these medical devices can wirelessly communicate patients' health-related sensed data to the doctor's end, saving them from sudden death or severe condition, thanks to the growing Internet of Medical Things (IoMT) technology.

This thesis presents an examination of a meander-line implantable antenna put within a three-layer human body model, utilizing the Transmission Line Model. The developed antenna is then inserted within an implantable device, together with a printed circuit board, sensor, battery, and other components, and is coated with biocompatible polyvinyl alcohol. For in-vitro assessment of antenna performance, a comparable human body model of a multilayered model is created using the Transmission Matrix Method (TMM). TMM is used to estimate the effective complex permittivities of a three-layer heart model and a seven-layer brain model, with an accuracy of 98.46%.

The study examines the impact of ±20% variations in effective relative permittivity and conductivity on the performance of an implantable antenna system, including return loss (operating frequency and $S_{11}$), radiation (realized gain, fractional bandwidth), link performance (link margin), and safety measures (SAR for 1g and 10g body models). In the next phase, a tiny dual-band implantable antenna (volume of 21.53 $mm^3$) is adapted for C-Band 5G biotelemetry in Wireless Capsule Endoscopy (WCE) with higher gain, -10 dB impedance bandwidth, compactness, and particular absorption rate responses than previously published studies. This thesis discusses wireless far-field powering for

a leadless cardiac Transcatheter Pacing (TCP) system using a dual-wideband (1.3 GHz and 2.45 GHz) circular polarized tiny implantable antenna. In terms of performance characteristics, the proposed system outperforms leadless cardiac pacemakers that have been previously reported.

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