1. **Title**: Computational Biomedical Engineering
2. **Course Number**:
3. **Proposing Department**: BSBE
4. **Other Departments**: EE, ME
5. **Proposer**: Ketan Rajawat (EE)
6. **Units**: 3-0-0-0 [9]
7. **Duration of the course**: full semester
8. **Pre-requisites**: N/A
9. **Other interested faculty**: K Muralidhar (ME)
10. **Course objectives**: The goal of this course is to introduce students to computational approaches to biomedical problems. The course will introduce the students to state-of-the-art computational techniques, applications of computational tools, and instill an understand of how biological concepts and computational methods can be integrated to address complex biomedical problems. The overarching goal of the course is to provide students with a deep understanding of how computational modeling and simulation can be used to create personalized virtual representations of biological systems for various biomedical applications. After completing this course, the students are expected to have the knowledge and skills necessary to develop, analyze, and use technologies such as digital twins in healthcare.

S. No.	Topics	Number of Lectures
1	Signal and image processing algorithms, Spectra and correlations, computational modeling and simulation (physics-based models, solving PDEs, basics of finite element methods, inverting large matrices)	15
2	Linear and non-linear regression, basics of Optimization, inverse modeling, optimization algorithms and software libraries	12
3	Basics of Machine Learning, data-driven models, regression, neural networks,	10

4	Case studies: digital twins in healthcare, forward and inverse models, personalization, arterial networks, blood pumps, X-ray and MRI	3

11. **Short summary for the course booklet**: This course introduces students to computational aspects of biomedical engineering, covering state-of-the-art techniques and integrating biological concepts with computational methods to address complex biomedical issues. By focusing on computational modeling, simulation, and personalized virtual representations, students will gain the skills to develop and utilize technologies such as digital twins in healthcare applications.
12. **References**:
    a. Iserles, A. (2009). A first course in the numerical analysis of differential equations (No. 44). Cambridge University Press.
    b. Modeling and Simulation in Biomedical Engineering: Applications in Cardiorespiratory Physiology 1st Edition (2011) by Willem van Meurs
    c. Computational Modeling and Simulation Examples in Bioengineering (IEEE Press Series on Biomedical Engineering), Wiley, 2021
    d. Bishop, C.M. Pattern recognition and Machine learning, Springer, 2007.
    e. Kochenderfer, Mykel J., and Tim A. Wheeler. Algorithms for optimization. MIT Press, 2019.

Proposer

Ketan Rajawat

DPGC

SPGC