



NEURAL SCIENCE FOR ENGINEERS

PROF. VIKAS V

Department of Multidisciplinary

National Institute of Mental Health and Neurosciences (NIMHANS)

PRE-REQUISITES : Preferable, but not essential, to have taken the NPTEL Sensors and Actuators

INTENDED AUDIENCE : Engineering Students, Faculty from Engineering Colleges, Medical Students, Faculty from Medical Colleges

INDUSTRIES APPLICABLE TO : MathWorks, Open BCI, Neruoscan, Neuroelectrics

COURSE OUTLINE :

Several branches of engineering involve the study of the nervous system. Engineering students of various branches are expected to understand the nervous system. The module is designed for students to understand the functioning of the nervous system without a detailed understanding of biology. Further, the students will be exposed to engineering opportunities in developing technologies for understanding the functioning of the nervous system.

ABOUT INSTRUCTOR :

Dr. Vikas is a Professor of Neurosurgery at NIMHANS, Bangalore. He has been working at NIMHANS for over a decade. He completed his MCh in 2008 from Sree Chitra Tirunal Institute for Medical Sciences & Technology (SCTIMST), Thiruvananthapuram. Following MCh, he has obtained DNB in Neurosurgery and a fellowship in cerebrovascular surgery. Apart from clinical work, he also has a deep interest in Deep tech development. He pursues independent programs on neurosurgical robotics, autonomic neurosurgery, novel imaging techniques and is pursuing a Ph.D. in data sciences at IIIT-B. He has more than 50 peer-reviewed journal articles and conference proceedings in the field of neurosurgery and biomedical engineering. These include comprehensive clinical studies as well as engineering solutions for brain tumor management. He has developed machine learning models based on MR spectroscopy for the classification of gliomas. He has also developed devices for neurosurgical applications and rehabilitation of patients with neurological disorders. He is an expert in intraoperative ultrasound for neurosurgery.

COURSE PLAN :

Week 1: Introduction to the Nervous System and Basic Structure of the Nervous System

Week 2: Evolutionary Lessons in Nervous System Function and Hierarchy of Neural Function from the Cell to Large Networks

Week 3: Signal Transmission, Analog Signal Processing, and Digital Signal Processing in the Nervous System

Week 4: The OS, Servomechanisms, and Control Systems in the Nervous System

Week 5: Theories of Learning and Mechanisms of Learning

Week 6: Biological Basis of Contemporary Neural Networks and Neural Substrates for Contemporary Neural Networks

Week 7: Computational Neurobiology, Brain-Computer Interfaces: Neuromodulation and Recordings: Brain-Computer Interfaces (BCI) Devices and Systems, Introduction to BCI Devices for Neural Recording and Stimulation.

Week 8: Introduction to Neuro-biopotentials: EEG, EMG and ECoG: Introduction to biopotentials, Data Acquisition, Signal Acquisition, Conditioning, and Processing.

Week 9: Introduction to the development of BCI devices I

Week 10: Introduction to the development of BCI devices II

Week 11: Microdevices for Neural Stimulation and Recording: Flexible Devices for ECoG Recordings and Neural Stimulation, Microneedles for Measuring Local Field Potentials (LFPs), and Bioresorbable Devices for ECoG Recordings.

Week 12: Demonstration of BCI Devices: Packaging, Implantation, and Recording: Packaging Techniques for BCI devices, Implantation of BCI devices, Interfacing with Read-out Electronics and Recording ECoG Signals.