Circuits, Microsystems and Packaging Techniques Intended for Autonomous Brain-Machine Interfaces

Overview of the course:

Emerging Brain-Machine Interfaces (BMIs) for diagnostic and recovery of neural vital functions are promising alternative to study neural activities underlying cognitive functions and pathologies. This tutorial covers the architecture of typical BMI intended for wireless neuro-recording and neuro-stimulation. Massively parallel multichannel spike recording through large arrays of microelectrodes will be introduced. Then the main building blocks used to implement such typical devices will be described. In particular, bio-amplifiers dedicated for very-low amplitude signal acquisition and for stimulation drivers of high-impedance loads. Attention will be paid to integrated bio-potential neural bio-amplifiers. Then, interference reduction, as well as low-power design optimization will be discussed. Biosensors intended to convert chemical signals to electrical ones could allow real-time measurement of pH, oxygen, nitric oxide concentrations, and Lab-on-chip technologies. Some other biosensors are being developed to allow helping to learn about the progression of diseases such as tumours. Also, the tutorial includes wireless power and data links to the implants. It encloses electromagnetic inductive links. Power sources and energy transfer based-on transcutaneous RF inductive powering. Power management and efficiency, data recovery, up- and downlink data transmissions, various modulation and demodulation circuitries. Tests and validation of devices: electrical, mechanical, package, heat, reliability will be summarized. Case studies will be covered and include research activities dedicated to vision recovery. First, we present the recording strategy used to understand the mechanism of vision, then the implant used to apply direct electrical micro-stimulation, to present the environment as phosphenes in the visual field of the blind, will be shown. As another case study, we will summarize latest activities on locating the seizure foci using multimodal fNIRS/EEG processing. Then, for refractory cases to surgery and medications, we will show the onset detecting seizure and techniques to stop it, using bioelectronics implant.

Modules	**This course consists of one module only.** **20 December 2016 to 24 December 2016.**
You Should Attend If You are	▪ Students of BTech, MTech, PhD, research scholars and faculty members of academic institutions and technical institutions. ▪ Executives, engineers and researchers from manufacturing, service and government organizations, including R&D laboratories.
Registration Fees	The participation fees for attending the course is as follows: **Overseas Participants: US$ 200** **Industry/ Research Organizations: Rs. 5000** **Participants from Academic Institutions: Rs. 2000** **Research Scholars/Students/Alumni: Rs. 1000 (Rs. 500 for SC/ST students)** After registration on GIAN portal http://www.gian.iitkgp.ac.in/GREGN/index, the candidates are advised to submit the prescribed fee in the form of DD in favor of **"Registrar, DTU"** payable at Delhi along with printout of online submitted application form to **Dr. Neeta Pandey, Course Coordinator (GIAN), Department of Electronics and Communication Engineering, Delhi Technological University, Bawana Road, Delhi-110042** on or before 10.12.2016. The shortlisted participants will be informed through e-mail. The above fee includes all instructional materials, computer use for tutorials and assignments and laboratory equipment usage charges. The course fee does not include boarding and lodging.

Teaching Faculty

Dr. Mohamad Sawan got his PhD from Sherbrooke University, Canada. He joined Polytechnique Montréal in 1991 where he is currently a Professor of Microelectronics and Biomedical Engineering. He holds a Canada Research Chair in Smart Medical Devices and he is leading the Microsystems Strategic Alliance of Quebec (ReSMiQ). He published more than 700 scientific papers, 2 books, 12 book chapters, and he offered more than 200 talks/tutorials around the world. He was awarded several patents pertaining to the field of biosensors and bioactuators. He is Editor-in-chief of the IEEE Transactions on Biomedical Circuits and Systems, and editor, co-editor and co-founder of several scientific journals and conferences. He received several awards, among them the Bombardier Medal, the Jacques-Rousseau Award, the Medal of Merit from the Lebanese President. He is Fellow of the Canadian Academy of Engineering, Fellow of the Engineering Institutes of Canada, Fellow of the IEEE, and he is "Officer" of the National Order of Quebec.

Host Faculty

Neeta Pandey is Assistant Professor in ECE department, Delhi Technological University. She received her M.E. in Microelectronics from BITS Pilani and Ph.D. from Guru Gobind Singh Indraprastha University, Delhi. She has served in Central Electronics Engineering Research Institute, Pilani, Indian Institute of Technology, Delhi, Priyadarshini College of Computer Science, Noida and Bharati Vidyapeeth's College of Engineering, Delhi in various capacities. She is having approximately 27 years of teaching and research experience in Electronics and Communication Engineering. A life member of ISTE, and senior member of IEEE, USA, she published more than 150 papers in international, national journals of repute and conferences. Her research interests are in analog and digital VLSI design.

Rajeshwari Pandey is Assistant Professor in Department of Electronics and Communication Engineering, Delhi Technological University, Delhi. She received her B.Tech. (Electronics and Telecommunication) from J. K. Institute of Applied Physics, University of Allahabad, M.E (Electronics and Control) from BITS, Pilani, and Ph.D from Faculty of Technology, Delhi University. She has served BITS Pilani, AERF, Noida and Priyadarshini College of Computer Science, Noida in various capacities. She is having approximately 23 years of teaching and research experience in Electronics and Communication Engineering. Currently, her research interests include analog integrated circuits and microelectronics. She published more than 60 papers in international, national journals of repute and conferences. She is life member of IETE, ISTE and member of IEEE, IEEE WIE.

Course Coordinator

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For Registration:
http://www.gian.iitkgp.ac.in/GREGN/index

Tentative Course Schedule

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20th December 2016
Registration: 09:00-10:00
Inauguration: 10:00 to 11:00

Date	Time	Activity	Topic
Tuesday 20th Dec 2016	11:30-12:30	Lecture 1	Introduction to Smart Medical Devices, Brain-Machine interfaces & Physiologic Systems
	13:30-15:00	Lecture 2	Neural conduction, and Model of the Hodgkin-Huxley membrane.
	15:00-17:00	Laboratory 1	Project alternatives
Wednesday 21st Dec 2016	10:00-12:00	Lecture 3	Background of CMOS Integrated circuits, and Basic electronic elements
	13:30-15:00	Lecture 4	Typical Building Blocks: Bioamplifiers, Stimulators, etc.
	15:00-17:00	Laboratory 2	Projects (Continued)
Thursday 22nd Dec 2016	10:00-12:00	Lecture 5	Harvesting Energy from various sources, and bidirectional wireless data transmission.
	13:30-15:00	Lecture 6	Electrodes-tissue interfaces, biosensors and Lab-on-CMOS-chip platforms
	15:00-17:00	Laboratory 3	Projects (Continued)
Friday 23rd Dec 2016	10:00-12:00	Lecture7	Case Study 1 : Neuromodulation and neuro-stimulation to control Bladder function
	13:30-15:00	Lecture 8	Case Study 2 : Non-invasive and Implantable Devices for Epilepsy
	15:00-17:00	Laboratory 4	Projects (Continued)
Saturday 24th Dec 2016	10:00-11:00	Lecture 9	Case Study 3 : intracortical recording and microstimulations for vision recovery
	11:00-12:00	Lecture 10	Summary
	14:00-15:00		Examination and evaluation
	15:00-15:30		Closing remarks and certificate distribution