VLSI IN BIOMEDICAL SIGNAL PROCESSING

(Elective Subject)

Course Code:	17M1WEC331	**Semester:**	3rd Semester, M. Tech (ECE) PhD
Credits:	3	**Contact Hours:**	L-3, T-0,P-0

Course Objectives

The objective of the VLSI in Biomedical Signal Processing is to address the research, development and design problems and advance their solutions in VLSI circuits for embedded system and ubiquitous computing applications. The areas are Embedded System design, Power Electronics, Wireless networks; Signal processing, Biomedical Electronics, Electronic Instrumentation, and Audio and Speech Processing.

Course Outcomes

After studying this course the students would gain enough knowledge

1. Basic concepts in Digital CMOS circuit design.
2. To make an in depth study of DSP structures amenable to VLSI implementation.
3. To enable students to design VLSI system with high speed and low power.
4. Improve the speed of digital system through transformation techniques.
5. Perform pipelining and parallel processing in FIR/IIR systems to achieve high speed and low power.
6. Have knowledge of the principle operation and design and the background knowledge of biomedical instruments and specific applications of Biomedical engineering.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	**INTRODUCTION TO COMPUTERS IN MEDICINE** : Characteristics of medical data**,** What is a medical instrument? Iterative definition of medicine, Evolution of microprocessor-based systems, The microcomputer-based medical instrument, Generalised Instrumentation system, The Biopotential Amplifier, The Instrumentation Amplifier, Characteristics of bio medical signal, Circuit Enhancements, Electrical Interference Reduction, Filtering, Artifact Reduction	Veeramachaneni : Chapter 1	2
2.	**ADDERS :** Review of Existing Adder Designs : Ripple Carry Adder (RCA), Carry Select Adder (CSA), Carry Look-Ahead Adder (CLA), Parallel Prefix- based Adder (PPA); Design and Implementation of Efficient Sum Computation Block for Higher Bit Sparse Adders; Design and Implementation of Higher Bit Sparse Adder	Veeramachaneni : Chapter 2	6

3	**COMPRESSORS AND COUNTERS :** Existing Compressor Designs : 3-2 Compressor , 4-2 Compressor , 5-2 Compressor; Efficient Compressor Designs using CMOS ; Designs of Counters : (3, 2) Counter, (7, 3) Counter , (15, 4) Counter , (31, 5) Counter; Design and Implementation of Efficient Parallel Counters	Veeramachaneni : Chapter 3	8
4	**SIGNAL PRE-PROCESSING** *SIGNAL CONVERSION* : Sampling basics, Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits, Lab: Signal conversion *SIGNAL AVERAGING* : Basics of signal averaging , Signal averaging as a digital filter, A typical averager , Software for signal averaging , Limitations of signal averaging . *SIGNAL COMPRESSOR/ DECOMPRESSOR* *DATA REDUCTION TECHNIQUES* : Turning point algorithm, AZTEC algorithm , Fan algorithm , Huffman coding *OTHER TIME- AND FREQUENCY-DOMAIN TECHNIQUES* **:** The Fourier transform , Correlation, Convolution , Power spectrum estimation	TOMPKINS : Chapter 3, 4	7
5	**BASICS OF FILTERING** : Digital filters, The *z* transform, Elements of a digital filter, Types of digital filters, Transfer function of a difference equation, The *z*-plane pole-zero plot, The rubber membrane concept *FINITE IMPULSE RESPONSE FILTERS* : Characteristics of FIR filters, Smoothing filters, Notch filters, Derivatives, Window design, Frequency sampling, Min-max design , Lab: FIR filter design *INFINITE IMPULSE RESPONSE FILTERS* **:** Generic equations of IIR filters , Simple one-pole example, Integrators , Design methods for two-pole filters, Lab: IIR digital filters for ECG analysis *INTEGER FILTERS* **:** Basic design concept, Low-pass integer filters, High-pass integer filters, Bandpass and band-reject integer filters, The effect of filter cascades, Other fast-operating design techniques, Design examples and tools, Lab: Integer filters for ECG analysis *ADAPTIVE FILTERS***:** Principal noise canceller model, 60-Hz adaptive cancelling using a sine wave model , Other applications of adaptive filtering	TOMPKINS : Chapter 5, 6, 7, 8	12
6	**VLSI IN BSP** : Digital signal processors, High-performance VLSI signal processing, VLSI applications in medicine , VLSI sensors for biomedical signals, VLSI tools, Choice of custom, ASIC, or off-the-shelf components		**7**
		Total Number of Lectures	42

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
   - 10 Marks : Class performance & Assignments
   - 10 Marks : Quizzes
   - 5 marks : Attendance

Text Books

1. W.J. TOMPKINS , "BIOMEDICAL DIGITAL SIGNAL PROCESSING : C-Language Examples and Laboratory Experiments for the IBM® PC", 2000.

Reference Books

1. Sreehari Veeramachaneni , "Design of Efficient VLSI Arithmetic Circuits", PhD Thesis, International Institute of Information Technology, Hyderabad
2. K.K.Parhi, "VLSI Digital Signal Processing Systems", John-Wiley, 2007
3. U. Meyer -Baese," Digital Signal Processing with FPGAs", Springer, 2004
4. W.Burleson, K. Konstantinides, T.H. Meng," VLSI Signal Processing"",1996.
5. R.J. Higgins, "Digital signal processing in VLSI", 1990.
6. S.Y.Kung, H.J. Whitehouse, "VLSI and modern signal processing", 1985
7. Carr and Brown, Biomedical Instrumentation.
8. Cromwell, Biomedical Instrumentation and Measurement, PHI.
9. Neil Weste and David Harris, "CMOS VLSI Design", 4th Ed., Addison Wesley, 2011.
10. Douglas A Pucknell et al, "Basic VLSI Design", 3rd Ed., Prenctice Hall, 2004
11. Sung-Mo Kang, Yusuf Leblebici : CMOS Digital Integrated Circuits Analysis and Design",Tata McGraw-Hill Edition 2003