



Syllabus

ALaRI

Master of Engineering in Embedded Systems Design

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DIGITAL SIGNAL PROCESSING

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Dates of the course

Second Quarter, January 2002, 24hours

Overview of the course

This course is aimed at illustrating the relevance and need for signal processing techniques in present-day multimedia and communications systems, and giving an overview of a few major DSP subdomains. First, a DSP basics refresh is given (linear systems and transforms, filter design and realization). Then an introduction is given to multi-rate systems and filter banks, illustrated by applications such as subband coding and transmultiplexers, as well as optimal and adaptive filtering, illustrated by such applications as line echo cancellation and channel equalization. Finally, two DSP case studies are given, one on high-

speed telephone line modems (ADS/VDSL) and one on wireless communications, with emphasis on DSP aspects of so-called 'smart antennas'.

Day 1 (Tuesday)

1. Morning: lecture-1 (2 hours, e.g. 10.00->12.00)

GENERAL INTRODUCTION

Relevance of DSP (in digital communications, in multimedia applications)
Course overview/preview

2. Afternoon: lecture-2 (2 hours, e.g. 13.30->15.30)

BACKGROUND/DSP BASICS REFRESH

Linear systems, transfer functions, z-transform, DFT/FFT
Linear filters
Filter realization

3. Afternoon: ex.session-1 (2.5 hours, e.g. 15.30->18.00)

Day 2 (Wednesday)

4. Morning: lecture-3 (2 hours, e.g. 10.00->12.00)

INTRODUCTION TO MULTIRATE SYSTEMS AND FILTER BANKS

Upsampling/interpolation, downsampling/decimation, sampling rate conversion
Filter banks
Applications: subband coding, transmultiplexers

5. Afternoon: lecture-4 (2 hours, e.g. 13.30->15.30)

INTRODUCTION TO OPTIMAL AND ADAPTIVE FILTERS

Wiener filters and least squares estimation
LMS, RLS
Applications: channel equalization, line echo cancellation

6. Afternoon: ex.session-2 (2.5 hours, e.g. 15.30->18.00)

Day 3 (Thursday)

7. Morning: lecture-5 (2 hours, e.g. 10.00->12.00)

CASE STUDY: ADSL MODEMS

Modem technology
Multicarrier modulation
DSP Challenges: Equalization, echo cancellation, interference cancellation

8. Afternoon: ex.session-3 (2.5 hours, e.g. 13.30->16.00)

9. Afternoon: ex.session-4 (2.5 hours, e.g. 16.00->18.30)

Day 4 (Friday)

10. Morning: lecture-6 (2 hours, e.g. 10.00->12.00)

CASE STUDY: WIRELESS COMMUNICATIONS

Cellular systems (GSM)

DSP Challenges: Equalization, interference cancellation, multiple access, smart antennas, MIMO transmission

11. Afternoon: ex.session-5 (2.5 hours, e.g. 13.30->16.00)

Notes on the Instructor

Marc Moonen received the electrical engineering degree and the PhD degree in applied sciences from the Katholieke Universiteit Leuven, Leuven, Belgium, in 1986 and 1990 respectively. He has been a research associate with the Belgian National Fund for Scientific Research, since 1994, and an Associate Professor, since 2000, both at the Electrical Engineering Department of the Katholieke Universiteit Leuven.

His research activities are in digital signal processing, digital communications and audio signal processing. He received the 1994 K.U. Leuven Research Council Award, the 1997 Alcatel Bell (Belgium) Award (with Piet Vandaele), and was a 1997 'Laureate of the Belgium Royal Academy of Science'. He is chairman of the IEEE Benelux Signal Processing Chapter, a EURASIP AdCom Member, and a member of the editorial board of 'Integration, the VLSI Journal' and 'Applied Signal Processing'.