CS4156 – Intro. to Applied Digital Signal Processing

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Administrivia

Lecture Hours:		Mon. 16h00	*SG21A*
		Fri. 15h00	*CSG01*
Tutorials	**A**	Fri. 09h00	*C1058*
Labs	**A**	Mon. 09h00	*CS144*

Grading Instruments:

Final:	70%		Week 15
Mid-Term Exam	15%		Week 7 / 8
Laboratory	15%		Weeks 1 - 12
Attendance		5%	
Completion		5%	
Report		5%	

The repeat exam in this module (in September ’08) will count for 70% of the overall grade.

Administrivia (contd.)

Grades:

F	0 – 29
D2	30 – 34
D1	35 – 39
C3	40 – 47
C2	48 – 51
C1	52 – 55
B3	56 – 59
B2	60 – 63
B1	64 – 71
A2	72 – 79
A1	80 – 100

Reading List:

- *Signal Processing First* by McClelland, Schafer, and Yoder; On SL in Library
- *Getting Started with Matlab, Version 6* by Pratap, R.
- *Digital Signal Processing: A Practical Approach* by Ifeachor and Jervis

Module Outline

- Intro. to discrete signal processing: Continuous vs Discrete models
- Architecture of Digital Signal Processing Systems: Analogue-to-Digital (A-to-D) and D-to-A conversion; Sampling; Filtering; Storage; Impulse Response
- Digital Filters: Convolution; Infinite Impulse Response; Finite Impulse Response
- Transformation of Signals: Fourier, Discrete Fourier, Windowing, Warping
- Signal Analysis and Synthesis: Filtering and Transformation; Signal Generation; Morphing Applications; Digital Audio and Video; Other applications (radar, healthcare)
- Common File and Data Formats: `.wav`, `.aiff`, `.au`, `.avi`, `.jpeg`, `.mpeg`
- Protocols: Streaming; Compression

Learning Outcomes

Learning Outcome	**Ass. Method**
Demonstrate a knowledge of the software package MATLAB	Written exam, lab. work
Demonstrate an understanding of the role of the choice of sampling rate in system design	Written exam, lab. work
Demonstrate a working knowledge of Fourier Series in the synthesis of waveforms	Written exam
Be able to identify (and justify) a Linear Time-Invariant system	Written exam
Design a digital filter with specified pass bands	Written exam, lab. work
Be able to analyse signals and their spectra in the frequency or time domains by being able to perform FFT, DFT and z-transforms on the signals	Written exam, course work

CS4156 Home Page

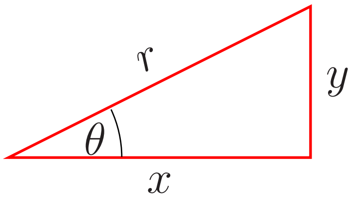
- All lectures, homeworks, past exams, etc. can be found on the class home page: `garryowen.csisdmz.ul.ie/~cs4156/`

Homework

- Buy SPF in bookshop
- Read SPF Appendix A on Complex Numbers (see resource matrix)
- Read Complex Numbers Revision tutorial from resource matrix
- These will be needed for this week's lab; and, Chapter 1 (Intro. to Systems)

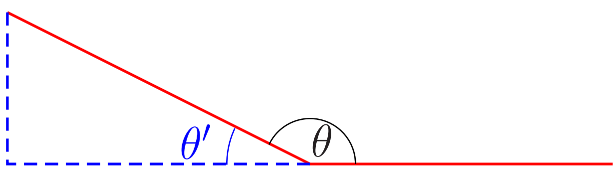
Complex Numbers

Trigonometry



$$\sin\theta = \frac{y}{r}$$
$$\cos\theta = \frac{x}{r}$$
$$\tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{y}{x}$$

- We always work in angles of radians: $360° = 2\pi$ radians; $90° = \frac{\pi}{2}$ radians, $135° = \frac{3\pi}{2}$ and, $45° = \frac{\pi}{4}$ radians
- Log tables usually provide $\cos, \sin$ and $\tan$ for angles $0 \le \theta \le \pi/2$
- If $\theta > \frac{\pi}{2}$:



Principal angle Angles are expressed as $-\pi \le \theta \le \pi$

If $\theta > 2\pi$, we repeatedly subtract off 2π until $0 \le \theta' \le 2\pi$: $\theta' = \theta - \lfloor\frac{\theta}{2\pi}\rfloor 2\pi$; put another way, $\theta = \theta' + k \times 2\pi, k \ge 0$

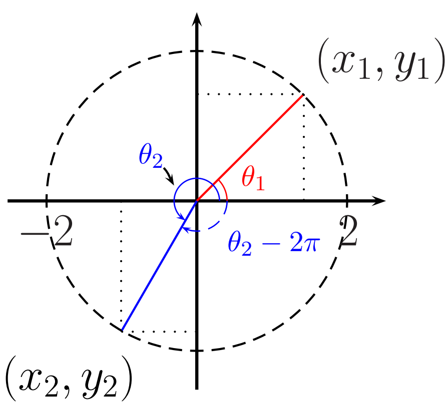
Further, if $\pi < \theta' < 2\pi$, then $\theta'' = \theta' - 2\pi$

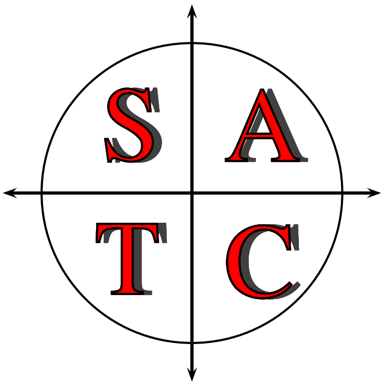
We will restrict ourselves to a circle and think of our angles within that in terms of x and y

$x_1 = 2\cos\theta_1; y_1 = 2\sin\theta_1$

$x_2 = 2\cos\theta_2; y_2 = 2\sin\theta_2$

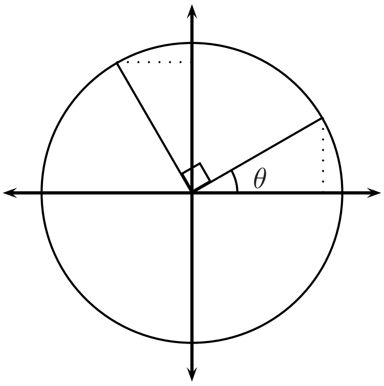
$x_2 = 2\cos(\theta_2 - 2\pi); y_2 = 2\sin(\theta_2 - 2\pi)$





Quadrants where $\sin\theta, \cos\theta$ and $\tan\theta$ are positive.

Trig. Identity (1)



$$\cos\theta = \sin(\theta + \frac{\pi}{2})$$

$$\sin\theta = -\cos(\theta + \frac{\pi}{2})$$

$$= \cos(\theta - \frac{\pi}{2})$$

Trig. Identity (2)

- We have seen that the points (x, y) in a circle of radius r are given by $(x, y) = (r\cos\theta, r\sin\theta)$
- Thanks to Pythagoras, in any RAT, $r^2 = x^2 + y^2$, so

$$\begin{aligned} r^2 &= x^2 + y^2 \\ &= (r\cos\theta)^2 + (r\sin\theta)^2 \\ &= r^2(\cos^2\theta + \sin^2\theta) \Rightarrow \cos^2\theta + \sin^2\theta = 1 \end{aligned}$$