Content and Time Schedule - Course "Radio Frequency Integrated Circuits", summer 2022

- **Version 09.3.2022**, date changes possible, please check our homepage for updates
- Monday: Start: 1.DS (7:30-9:00), duration: 1DS, location (if not otherwise announced): HÜL/S386/H
- Wednesday: Start: 2.DS (9:20-10:50), duration: 1DS, location (if not otherwise announced): GÖR 226
- Thursday: Start: 2.DS (9:20-10:50), duration: 1DS, location (if not otherwise announced): GÖR 226
- **The dates are not fully periodic! Hence, please take into account the individual dates as shown below!**
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Lectures			**Tutorials**		
No.	*Date*	*Content (slides/incl. appendixes)*	*No*	*Date*	*Content (tutors)*
1	4.4.22	**0.1 Prelude (13/13)** **1. Introduction (23/24)** 1.1 Timetable of inventions 1.2 Major inventors 1.3 RF frequency bands 1.4 RF applications and markets 1.5 IC market			
2	7.4.22	1.6 Energy consumption/pollution 1.7 Overview IC design procedure **2. Transceiver Frontends (27/34)** 2.1 Generic transceiver 2.2 Receivers 2.2.1 Heterodyne 2.2.2 Image rejection 2.2.3 Direct conversion 2.2.4 IQ 2.2.5 Digital IF			
3	11.4.22	2.3 Transmitters 2.3.1 Direct conversion 2.3.2 Direct modulation 2.4 Transceiver architecture example 2.5 50 Gb/s 200 GHz BiCMOS transceiver **3. S-Parameters & Impedance Trans. (42/47)** 3.1 Reflection coefficient 3.2 Smith chart 3.3 Mason rule 3.4 S-parameters	1	13.4.22	Paper discussion (Wagner)
4	14.4.22	3.5 Impedance transformation 3.6 Types of impedance matching	2	20.4.22	Impedance matching using the Smith chart I (Wagner)
5	25.4.22	**4. RF Basics (70/78)** 4.1 Stability 4.2 Power gain	3	27.4.22	Impedance matching using Smith chart II (Wagner)
6	28.4.22	4.3 Noise 4.4 Linearity and compression 4.5 Dynamic range			
7	2.5.22	**5. Transistors and Technologies (57/64)** 5.1 Overview 5.2 MOSFET 5.2.1 Functional principle 5.2.2 DC and small signal characteristics	4	4.5.22	Power gain and stability of MOSFET (Wagner)
8	5.5.21	5.2.3 Types 5.2.4 Small signal modelling 5.2.5 Speed parameters 5.2.5.1 Transit frequency 5.2.5.2 Maximum frequency of oscillation 5.2.6 Noise modelling 5.2.7 CMOS scaling 5.2.8 Advanced CMOS 5.3 Comparison of transistors and performances 5.4 Outlook towards Beyond Moore technologies			
9	9.5.22	**6. Passive Devices (34/42)** 6.1 Inductors 6.1.1 Q-factor 6.1.2 Improvement techniques 6.2 Capacitors 6.3 Varactors 6.4 Resistors	5-L	11.5.22	**LTSpice tutorial I** Introduction Design of a small signal MOSFET model (Joram)
10	12.5.22	6.5 Interconnects 6.5.1 On-chip interconnects 6.5.2 Off-chip interconnects 6.5.3 Ground connections **7. Basic Amplifiers (32/50)** 7.1 Common source 7.2 Common gate 7.3 Common drain 7.4 Cascode			

11	16.5.22	7.5 Biasing 7.5.1 Bias point 7.5.2 Bias circuitries 7.6 Wideband amplifiers 7.6.1 Resistive matching 7.6.2 Active matching 7.6.3 Feedback amplifier			
12	23.5.22	**8. Low Noise Amplifiers (24/26)** 8.1 General design considerations 8.2 Design considerations for a 3.6 GHz 5G CMOS LNA 8.3 Chip design examples 8.3.1 Narrowband 4.2-5.7 GHz MESFET LNA 8.3.2 Broadband 0-7.8 GHz SiGe HBT LNA	6	25.5.22	Advanced CMOS, passive devices, inductance and Q of inductor, improvement techniques (Wagner)
13	30.5.22	**9. Power Amplifiers (53/64)** 9.1 Choice of basic topology 9.2 Classic current source based amplifiers 9.2.1 Class-A 9.2.2 Class-B 9.2.3 Class-C 9.2.4 IC design example	7	1.6.22	Small signal analysis of common source circuit with source impedance (Wagner)
14	2.6.22	9.3 Switched amplifiers 9.3.1 Introduction 9.3.1 Class-D 9.3.2 Class-E 9.3.3 Class-F 9.4 Summary 9.5 Tradeoff between efficiency and linearity 9.6 Power combining 9.6.1 Amplifier arrays 9.6.2 Transformer-coupled amplifier			
15	13.6.22	**10. Mixers (29/37)** 10.1 Mixing procedure 10.2 Device nonlinearities 10.3 Mixer topologies 10.3.1 Transconductance mixer 10.3.2 Differential pair mixer 10.3.3 Gilbert cell mixer 10.3.4 Comparison of topologies	8-L	15.6.22	**LTSpice tutorial II** Design of a narrow band amplifier (Joram)
16	20.6.22	**11. Oscillators (54/73)** 11.1 Introduction 11.2 Analysis 11.2.1 Time domain theory 11.2.2 Feedback theory 11.2.3 Negative resistance theory 11.3 Noise 11.3.1 Noise floor 11.3.2 Resonator shaped noise 11.3.3 Impact of flicker noise 11.3.4 Overall frequency response 11.3.5 Minimisation of noise			
17	27.6.22	11.4 Topologies 11.4.1 LC Gate resonator oscillator 11.4.2 Cross coupled oscillator **12. Conclusions (7/7)** 12.1 Summary 12.2 Exam 12.3 Info Lecture "ICs for Broadband Communications" 12.4 Job market for RF/Mixed-Signal/Analogue IC Design	9	29.6.22	Small signal oscillator analysis applying MOSFET model (Wagner)
18	4.7.22	Time Buffer Lecture	10-L	6.7.22	**LTSpice tutorial III** Large signal oscillator design (Joram)
			11	13.7.22	Open questions for exam (Joram, Wagner)