东南大学

2022 年国际暑期学校

项目主题：无线通信原理与关键技术国际暑期学校

开课院系：信息科学与工程学院

开设课程：无线通信系统概论

移动衰落信道建模

微波、毫米波与太赫兹前沿技术

开课时间：2022 年 7 月 5 日-2022 年 8 月 8 日

目录

1. 项目介绍

1.1. 项目主题：无线通信原理与关键技术国际暑期学校

International Summer School of Wireless Communication Principles and Key Technologies

1.2. 开课院系：信息科学与工程学院

School of Information Science and Engineering, Southeast University

1.3. 项目简介：

项目立足于东南大学信息学科综合优势，坚持学术导向，强化拓展培养，将通识教育、专业教育、学术交流和创新创业教育有机结合，全面提升学生综合素质。围绕无线通信系统的基本原理与前沿技术这一主题，开设《无线通信系统概论》、《移动衰落信道建模》、《微波、毫米波与太赫兹前沿技术》3 门全英文课程，由 4 名校内专任教师、9 名外籍教师、4 名企业教师共同参与，每门课程均包含理论授课、实验实践、国际大师讲座、企业教师讲座及参观座谈 5 部分内容。通过本项目的建设，学生将体验国内外专家学者的授课，接轨国际高校授课方式，紧密结合理论和应用，激发创新思维和学习积极性，为从事相关领域的工作和研究建立坚实基础。每门课程 32 学时，可获得 2 学分，校外/国际选课学生可提供课程证书。

This international summer school is based on the overall strengths of information subject of Southeast University (SEU). It adheres to academic-orientation and strengthens development training by integrating general education, professional education, academic exchange, and innovation & enterprise education, thus enabling overall improvements of students' comprehensive quality. The theme of the summer school is the basic principles and technology frontiers of wireless communication systems. Three English courses are included, i.e., Introduction to Wireless Communication System, Mobile Fading Channel Modeling, and Frontiers of Microwave, Millimeter-wave and Terahertz Technologies. Four SEU teachers, nine oversea teachers, and four company teachers will participate in this project. Each course has five parts, including theoretical lectures, labs/tutorials, invited talks given by international masters, invited talks given by industrial experts, and visits to state key labs. From this international summer school, students will experience lectures given by

experts at home and abroad, be geared to teaching styles of international universities, closely combine theory and applications, inspire innovative thinking and learning enthusiasm, thus laying a solid foundation for future work and research in related areas. Each course has 32 class hours and 2 credits. Course certificates are available for international students and non-SEU students in Chinese universities.

2. 课程介绍

2.1. Introduction to Wireless Communication System (无线通信系统概论)

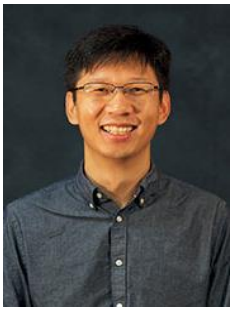
This course focuses on the fundamental theories and key technologies of wireless communication system, along with process of digital signal modulation, transmission, reception, and equalization techniques. Various modulation techniques will be discussed, as well as the performance analysis methods. We will also introduce some advanced topics in digital communications, such as channel equalization, channel coding and pulse shaping, multiple access, and OFDM. Four invited lectures on intelligent reflecting surface communications, green and intelligent communications, and 6G wireless communication technologies will also be given.

2.1.1. 教学日历

时间 Time	节数 Class	课程内容 Content	授课教师 Lecturer	授课平台 Platform
8-Jul 15:50- 17:25	**C1- C2**	Introduction to wireless communication system	Lei Zhang	https://voovmeeting.com/dm/dOYOFspY4yZL #VooV Meeting：671-092-180
9-Jul 15:50- 17:25	**C3- C4**	Digital signal modulation and demodulation	Lei Zhang	https://voovmeeting.com/dm/uLereMVTV6JN #VooV Meeting：404-043-753
10-Jul 15:50- 17:25	**C5- C6**	Digital signal modulation and demodulation	Lei Zhang	https://voovmeeting.com/dm/PZp24JGKC8Tl #VooV Meeting：384-074-089
14-Jul 18:30- 19:15	**C7**	Wei Zhang's lecture: Intelligent reflecting surface for smart radio	Wei Zhang	https://voovmeeting.com/dm/L637afxy8Hme #VooV Meeting：384-089-308
17-Jul	**C8-**	Signal detection theory and	Lei Zhang	https://voovmeeting.com/dm/W

18:30-20:55	**C10**	BER performance analysis		i4GiJ4h488j #VooV Meeting：312-097-846
18-Jul 18:30-20:55	**C11-C13**	Channel equalization	Lei Zhang	https://voovmeeting.com/dm/gUIfcRjRu3vV #VooV Meeting：994-026-635
19-Jul 18:30-20:55	**C14-C16**	Channel coding and pulse shaping	Lei Zhang	https://voovmeeting.com/dm/zLq38Czi5wGU #VooV Meeting：500-021-068
20-Jul 18:30-20:55	**C17-C19**	Multiple access and wireless channel	Lei Zhang	https://voovmeeting.com/dm/f00Nu84jJ3tx #VooV Meeting：503-092-205
21-Jul 18:30-20:55	**C20-C22**	Multiple access and wireless channel	Lei Zhang	https://voovmeeting.com/dm/qwwmjIx1GAe2 #VooV Meeting：808-083-045
22-Jul 14:00-16:35	**C23-C25**	Experiments	Jie Huang	https://voovmeeting.com/dm/iHRuwF1FHafH #VooV Meeting：832-093-180
22-Jul 18:30-20:55	**C26-C28**	OFDM	Lei Zhang	https://voovmeeting.com/dm/PENWKGEMebcr #VooV Meeting：592-036-753
24-Jul 18:30-19:15	**C29**	Jian Li's lecture: 6G: The next horizon	Jian Li	https://voovmeeting.com/dm/RIlgAr6b3qfG #VooV Meeting：703-010-750
24-Jul 19:20-20:05	**C30**	Experiments and discussion	Jie Huang	https://voovmeeting.com/dm/RIlgAr6b3qfG #VooV Meeting：703-010-750
27-Jul 19:20-20:05	**C31**	Rui Zhang's lecture: Intelligent reflecting surface (IRS) empowered wireless networks: Recent advance and future trend	Rui Zhang	https://voovmeeting.com/dm/okhIWsAPeuPx #VooV Meeting：713-060-840
29-Jul 16:00-16:45	**C32**	John Thompson's lecture: Overview of green and intelligent technologies for future wireless systems	John Thompson	https://voovmeeting.com/dm/BguTPywVzkKy #VooV Meeting：729-035-219

2.1.2. 外教介绍



张磊是英国格拉斯哥大学（University of Glasgow）副教授，在英国谢菲尔德大学获博士学位。他在无线通信网络、物联网分布式系统、区块链、自治系统方面具有学术界和工业界的研究经验。拥有 30 多个国家及地区的 20 项专利，出版专著 3 部，发表论文 150 多。他是 IEEE IoTJ、IEEE WCL、Digital Communications and Networks 的副编辑，也是 IEEE JSAC 的客座编辑。他获得了 2019 年 IEEE ComSoc TAOS 技术委员会最佳论文奖、2021 年 IEEE ICEICT 最佳论文奖。他是 IEEE TCCN 无线区块链网络特别兴趣小组的创始主席。他在 IEEE ICC 2020、IEEE PIMRC 2020、IEEE Globecom 2021、IEEE VTC-Fall 2021、IEEE ICBC 2021 以及 EUSIPCO 2021 会议做 tutorial 报告。

Lei Zhang is a Senior Lecturer at the University of Glasgow, U.K. He received his Ph.D. from the University of Sheffield, U.K. He has academia and industry combined research experience on wireless communications and networks, and distributed systems for IoT, blockchain, autonomous systems. His 20 patents are granted/filed in 30+ countries/regions. He published 3 books, and 150+ papers in peer-reviewed journals, conferences and edited books. Dr. Zhang is an associate editor of IoT Journal, IEEE Wireless Communications Letters and Digital Communications and Networks, and a guest editor of IEEE JSAC. He received the IEEE ComSoc TAOS Technical Committee Best Paper Award 2019 and IEEE ICEICT'21 Best Paper Award. Dr. Zhang is the founding Chair of IEEE Special Interest Group on Wireless Blockchain Networks in Cognitive Networks Technical Committee (TCCN). He delivered tutorials in IEEE ICC'20, IEEE PIMRC'20, IEEE Globecom'21, IEEE VTC'21 Fall, IEEE ICBC'21 and EUSIPCO'21.

John Thompson 是爱丁堡大学工程学院教授，1995 年获爱丁堡大学博士学位。他在天线阵列处理、协同通信系统与高能效无线通信及应用等专业领域发表了超过 350 篇论文。他是在丹麦奥尔堡举办的 IEEE SmartGridComm 会议的共同主席。目前，他参与了两个项目，研究信号处理与下一代无线通信的新概念。2016 年因在天线阵列与多跳通信方面的贡献当选为 IEEE Fellow。2015-2018 年入选全球高被引科学家。

John Thompson is currently a Professor with the School of Engineering, University of Edinburgh. He received the Ph.D. degree from the University of Edinburgh, Edinburgh, U.K. in 1995. He has authored or coauthored more than 350 papers on the topics of his research interests, which include antenna array processing, cooperative communications systems, energy efficient wireless communications, and their applications. Dr. Thompson was the Co-Chair of the IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm) held in Aalborg, Denmark. He currently participates in two U.K. research projects, which study new concepts for signal processing and next-generation wireless communications. In January 2016, he was elevated to Fellow of IEEE for contributions to antenna arrays and multihop communications. During 2015-2018, he was recognized by Thomson Reuters as a highly cited researcher.

张伟是澳大利亚新南威尔士大学教授，2005 年获香港中文大学博士学位。当前研究兴趣包括无人机通信、5G 及 B5G 通信。他获得了 6 篇 IEEE 会议及通信学会技术委员会的最佳论文奖。2015 年当选 IEEE Fellow，是 2016-2017 年 IEEE 通信学会杰出讲师、IEEE 通信学会副主席。他担任了通信学会多个领导职位，包括理事会成员（2018-2020）、无线通信技术委员会主席（2019-2020）、亚太委员会副主任（2016-2021）、IEEE WCL 主编、APCC 2017 及 ICCC 2019 技术程序委员会主席、亚太委员会及 IEEE TCCN 奖励委员会主席。他还担任多个通信学会理事会成员，包括期刊理事会、技术委员会认证委员会、财务委员会、信息技术委员会、IEEE TGCN 及 IEEE NL 理事会。他还曾担任多个期刊编辑，包括 IEEE TCOM、IEEE TWC、IEEE TCCN、IEEE JSAC 认知无线电专刊。

Wei Zhang is a Professor at University of New South Wales, Sydney, Australia. He received the Ph.D. degree from The Chinese University of Hong Kong in 2005. His current research interests include UAV communications, 5G and beyond. He received 6 best paper awards from IEEE conferences and ComSoc technical committees. He was elevated to Fellow of the IEEE in 2015 and was an IEEE ComSoc Distinguished Lecturer in 2016-2017. He is Vice President of IEEE Communications Society. Within the IEEE ComSoc, he has taken many leadership positions including Member-at-Large on the Board of Governors (2018-2020), Chair of Wireless Communications Technical Committee (2019-2020), Vice Director of Asia Pacific Board (2016-2021), Editor-in-Chief of IEEE Wireless Communications Letters (2016-2019), Technical Program Committee Chair of APCC 2017 and ICCC 2019, Award Committee Chair of Asia Pacific Board and Award Committee Chair of Technical Committee on Cognitive Networks. In addition, he has served as a member in various ComSoc boards/standing committees, including Journals Board, Technical Committee Recertification Committee, Finance Standing Committee, Information Technology Committee, Steering Committee of IEEE Transactions on Green Communications and Networking and Steering Committee of IEEE Networking Letters. Currently, he serves as an Area Editor of the IEEE Transactions on Wireless Communications and the Editor-in-Chief of Journal of Communications and Information Networks. Previously, he served as Editor of IEEE Transactions on Communications, IEEE Transactions on Wireless Communications, IEEE Transactions on Cognitive Communications and Networking, and IEEE Journal on Selected Areas in Communications – Cognitive Radio Series.

张瑞在新加坡国立大学获电子工程学士（一等荣誉）、硕士学位，在美国斯坦福大学获电子工程博士学位。2007 年至 2010 年在新加坡科技局资讯通信研究院工作。2010 年至今在新加坡国立大学工作，现任电气与计算机工程系教授。已发表 200 多篇期刊论文与 180 多篇会议论文。当前研究兴趣包括无人机/卫星通信、无线传能、可重构 MIMO 以及优化方法。获 2011 年 IEEE 通信学会亚太地区最佳青年学者奖、2015 年新加坡国立大学青年学者奖、2020 年无线通信技术委员会表彰。获 2015 及 2020 年 IEEE Marconi 无线通信论文奖、2016 年 IEEE 通信学会亚太地区最佳论文奖、2016 年 IEEE 信号处理学会最佳论文奖、2017 及 2020 年 IEEE 通信学会 Heinrich Hertz 论文奖、2017 年 IEEE 信号处理学会 Donald G. Fink 综述论文奖、2017 年 IEEE TCGCC 最佳论文奖、2017 年 IEEE 信号处理学会青年作者最佳论文奖。2015 年至今入选科睿唯安全球高被引科学家。他担任 30 多个国际会议的技术程序委员会共同主席或组织委员会成员和 IEEE JSTSP 及 IEEE JSAC 3 个专刊的客座编辑。2012-2017 年任 IEEE 信号处理学会

SPCOM 技术委员会成员，2013-2015 年任 SAM 技术委员会成员，2014-2015 年任 IEEE 通信学会亚太理事会技术事物委员会副主席。2012-2016 年任 IEEE TWC 编辑，2015-2016 任 IEEE 绿色通信与网络系列编辑，2013-2017 年任 IEEE TSP 编辑，2016-2020 年任 IEEE TGCN 编辑。现任 IEEE TCOM 编辑，是 IEEE WCL 指导委员会成员、IEEE 信号处理学会和通信学会杰出讲师。

Rui Zhang received the B.Eng. (first-class Hons.) and M.Eng. degrees from the National University of Singapore, Singapore, and the Ph.D. degree from the Stanford University, Stanford, CA, USA, all in electrical engineering. From 2007 to 2010, he worked at the Institute for Infocomm Research, ASTAR, Singapore. Since 2010, he has been working with the National University of Singapore, where he is now a Professor in the Department of Electrical and Computer Engineering. He has published over 200 journal papers and over 180 conference papers. His current research interests include UAV/satellite communications, wireless power transfer, reconfigurable MIMO, and optimization methods. Dr. Zhang was a recipient of the 6th IEEE Communications Society Asia Pacific Region Best Young Researcher Award in 2011, the Young Researcher Award of National University of Singapore in 2015, and the Wireless Communications Technical Committee Recognition Award in 2020. He was a corecipient of the IEEE Marconi Prize Paper Award in Wireless Communications in 2015 and 2020, the IEEE Communications Society Asia-Pacific Region Best Paper Award in 2016, the IEEE Signal Processing Society Best Paper Award in 2016, the IEEE Communications Society Heinrich Hertz Prize Paper Award in 2017 and 2020, the IEEE Signal Processing Society Donald G. Fink Overview Paper Award in 2017, and the IEEE Technical Committee on Green Communications & Computing (TCGCC) Best Journal Paper Award in 2017. His co-authored paper received the IEEE Signal Processing Society Young Author Best Paper Award in 2017. He has been listed as a Highly Cited Researcher by Thomson Reuters/Clarivate Analytics since 2015. He served for over 30 international conferences as the TPC Co-Chair or an Organizing Committee Member and as the Guest Editor for three special issues on IEEE JOURNAL OF SELECTED TOPICS IN SIGNAL PROCESSING and IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS. He was an elected member of the IEEE Signal Processing Society SPCOM Technical Committee from 2012 to 2017 and the SAM Technical Committee from 2013 to 2015. He served as the Vice Chair for the IEEE Communications Society Asia Pacific Board Technical Affairs Committee from 2014 to 2015. He served as an Editor for IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS from 2012 to 2016, IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS: Green Communications and Networking Series from 2015 to 2016, IEEE TRANSACTIONS ON SIGNAL PROCESSING from 2013 to 2017, and IEEE TRANSACTIONS ON GREEN COMMUNICATIONS AND NETWORKING from 2016 to 2020. He is also an Editor of IEEE TRANSACTIONS ON COMMUNICATIONS. He serves as a member for the Steering Committee of IEEE WIRELESS COMMUNICATIONS LETTERS. He is a Distinguished Lecturer of the IEEE Signal Processing Society and the IEEE Communications Society.

李剑博士是华为无线技术实验室专家。他 2006 年获复旦大学电路与系统专业博士学位。曾在 CAS 的 SIMIT 部门工作一年。2007-2009 年在上海交通大学和阿尔卡特-朗讯任博士后，之后作为高级策略工程师加入阿尔卡特-朗讯。2011 年起加入华为无线技术实验室。期间，2017-2020 年任华为慕尼黑研究中心负责人。在华为，他作为专家参与领导了 5G 信道建模研究与标准化工作，是 3GPP 和 ITU-R 5G 标准化信道模型的主要贡献者。在慕尼黑研究中心期间，他领导团队参与了 5GPPP 项目，包括 5GCar、One5G、5G-MoNArch、5G-VINNI、5G-Croco 等。作为发起成员代表，他也参与了 5GAA 和 5G-ACIA 两个重大且成功的 5G2B 工业协会。他的研究兴趣包括 6G 信道建模、通感一体化以及 6G 候选技术的标准化。

Dr. Jian Li is an Expert of Wireless Technology Lab in Huawei. He received the Ph.D in Circuits and Systems from Fudan University in 2006. He worked in SIMIT of CAS for one year. From 2007 to 2009, he worked as a Post-Doctor in Shanghai Jiaotong University and Alcatel-Lucent Shanghai Bell. Since then, he joined Acatel-Lucent Shanghai Bell as an senior strategy engineer. He joined Huawei since 2011 and worked in Wireless Technology Lab. In between, he worked as a Lab director in Huawei Munich Research Center from 2017 to 2020. In Huawei, He was involved and leading in the 5G channel modeling research and standardization work as an expert. And he worked as a major contributor for 5G channel modeling standard in 3GPP and ITU-R. When he was in Munich Research Center, he was leading the team to join the 5GPPP projects, including 5GCar, One5G, 5G-MoNArch, 5G-VINNI, 5G-Croco, etc. As representative of the founding member, he also contributed to 5GAA and 5G-ACIA, two major and successful 5G2B industrial associations. And his research interests include 6G channel modeling, integrated communication and sensing, and pre-standardization of 6G candidate technologies.

2.2. Mobile Fading Channel Modeling (移动衰落信道建模)

This course focuses on mobile fading channel modeling methods. A brief introduction of mobile fading channel will be given, followed by channel statistical properties, various channel model parameter computation methods, and different channel modeling methods will be discussed. An overview of standard 5G channel models is then provided. Meanwhile, 6G key technologies and challenges in channel modeling will be investigated. Three invited lectures on vehicle-to-vehicle (V2V) channel measurements and modeling, LiFi channel modeling, and channel model evolution from 5G to beyond 5G will also be given.

2.2.1. 教学日历

时间 Time	节数 Class	课程内容 Content	授课教师 Lecturer	授课平台 Platform
5-Jul 14:00- 15:35	**C1-C2**	Fundamentals of Mobile Fading Channel Modeling	Cheng-Xiang Wang	https://voovmeeting.com/dm/sLyJOnCOHWY9 #VooV Meeting：706-089-239
5-Jul 18:30- 20:05	**C3-C4**	Fundamentals of Mobile Fading Channel Modeling	An-An Lu	https://voovmeeting.com/dm/csei389RHqQn #VooV Meeting：169-041-218
6-Jul 18:30- 20:05	**C5-C6**	Random Variables, Stochastic Processes, and Deterministic Signals	An-An Lu	https://voovmeeting.com/dm/9my9tW4RCLnV #VooV Meeting：717-030-855
11-Jul 15:50- 18:15	**C7-C9**	Characterization and Modeling of Mobile Fading Channels	Yang Miao	https://voovmeeting.com/dm/BLmBJaJivUji #VooV Meeting：143-080-001
12-Jul 18:30- 20:55	**C10-C12**	Characterization and Modeling of Mobile Fading Channels	Yang Miao	https://voovmeeting.com/dm/7m8ndDR8hXhZ #VooV Meeting：970-027-073
13-Jul 18:30- 20:05	**C13-C14**	Channel Model Parameter Computation Methods	Yang Miao	https://voovmeeting.com/dm/sOdHYJ7Rh8mW #VooV Meeting：661-039-450
16-Jul 18:30- 20:05	**C15-C16**	Experiments	An-An Lu	https://voovmeeting.com/dm/EPSBIqPKKRvU #VooV Meeting：814-038-097

17-Jul 16:40-18:15	**C17-C18**	Experiments	An-An Lu	https://voovmeeting.com/dm/RgwT2PIkvQ4D #VooV Meeting：929-019-754
19-Jul 16:40-18:15	**C19-C20**	Comparison of Spatial Channel Model and KBSM	An-An Lu	https://voovmeeting.com/dm/AdYqxrKfX6n7 #VooV Meeting：852-007-626
21-Jul 14:00-17:25	**C21-C24**	Non-Stationary High-Speed Train Wireless Channel Models	Jie Huang	https://voovmeeting.com/dm/sK5cAvPxlnoQ #VooV Meeting：836-036-386
23-Jul 18:30-20:55	**C25-C27**	Wireless Channel Models for 5G and Beyond	Jie Huang	https://voovmeeting.com/dm/YUm874UNeDCe #VooV Meeting：715-006-318
25-Jul 18:30-19:15	**C28**	Zhimeng Zhong's Lecture: Wireless channel model evolution from 5G to beyond 5G (5.5G)	Zhimeng Zhong	https://voovmeeting.com/dm/QGNUc2BcRxJT #VooV Meeting：644-036-262
26-Jul 11:00-11:45	**C29**	A. F. Molisch's Lecture: Measurement and modeling of vehicle-to-vehicle propagation channels	A. F. Molisch	https://voovmeeting.com/dm/bnbXGRMGqVd9 #VooV Meeting：489-018-389
26-Jul 18:30-20:05	**C30-C31**	Wireless Channel Models for 5G and Beyond	Jie Huang	https://voovmeeting.com/dm/OXzlRJbtwhBF #VooV Meeting：536-028-402
8-Aug 21:00-21:45	**C32**	Harald Haas's lecture: Indoor LiFi channel modeling	Harald Haas	https://voovmeeting.com/dm/oUBDq9Pkj4el #VooV Meeting：318-041-741

2.2.2. 外教介绍

苗阳分别于 2012 年、2015 年在东京工业大学国际发展工程系天线与无线传播实验室获硕士、博士学位。2010-2015 年任东京工业大学 Takada 实验室移动通信研究课题组研究助理，2015-2018 年在比利时鲁汶大学信息与通信技术、电子、应用数学研究所以及根特大学无线、水声、环境、专家系统实验室开展博士后研究。2017-2018 年在深圳捷豹电波科技有限公司任兼职资深天线工程师。2018-2019 年在南方科技大学任研究助理教授。自 2019 年 8 月起任荷兰特文特大学无线系统课题组助理教授。自 2021 年 11 月起兼任比利时鲁汶大学玛丽居里学者。研究兴趣包括天线与物理无线传播环境在物理层与系统级的相互作用机理，无线信道测量、建模与特性分析，多天线阵列配置，大规模天线拓扑回响与房间电磁学，无线信道在人体检测与姿态识别中的应用，无线设备空口测试，以及无人机等关键传播环境。

Yang Miao received the M.Sc. and Ph.D. degrees from the Antenna and Radio Propagation Laboratory, Department of International Development Engineering, Tokyo Institute of Technology, Japan, in 2012 and 2015, respectively. From 2010 to 2015, she was a Research Assistant with the Takada Laboratory, Mobile Communications Research Group, Tokyo Institute of Technology. From 2015 to 2018, she was a Post-Doctoral Researcher with the Institute of Information and Communication Technologies, Electronics, and Applied Mathematics, Universite Catholique de Louvain, Louvain-la-Neuve, Belgium, and IMEC, Wireless, Acoustics, Environment, and the Expert Systems Laboratory, Ghent University, Ghent, Belgium. From 2017 to 2018, she was a part-time Senior Antenna Engineer with Jaguar Radio Wave Corporation, Shenzhen, China. From 2018 to 2019, she was a Research Assistant Professor with the Southern University of Science and Technology, Shenzhen, China. Since August 2019, she has been an Assistant Professor with the Radio System Group, University of Twente, The Netherlands. Since November 2021, she has been also affiliated in part-time with KULeuven as a Marie Curie Individual Fellow. Her current research focuses on Joint Communication and Sensing, incorporating mobility, and human factors.Her research interests include the interactions between antennas and physical radio propagation environment in physical layer and system level; radio channel measurement, modeling, and characterization, multiantenna array

configuration and massive MIMO topology reverberation and room electromagnetics, applications of radio channel in human detection and posture identification, in over-the-air testing of wireless devices, and in critical propagation environment, such as unmanned aerial vehicle communications.

Andreas F. Molisch 分别于 1990、1994、1999 年在奥利地维也纳工业大学获硕士学位、博士学位、特许任教资格。随后 10 年在工业界，任职于 FTW、AT&T 贝尔实验室与三菱电机研究实验室（首席无线标准架构师）。2009 年任美国南加州大学教授，创立了 WiDeS 课题组。2017 年任命为 Solomon Golomb-Andrew 与 Erna Viterbi 讲席教授。研究兴趣包括无线传播信道、无线系统设计以及两者的相互作用机理。近期研究兴趣是 5G/B5G 无线信道测量与建模，通信、缓存、计算一体化，混合波束成形，基于 UWB/TOA 的定位，以及新型调制/多址接入方法。发表了 4 部书籍（包括第二版《无线通信》）、21 部书籍章节、260 篇期刊论文，以及 360 篇会议论文。他拥有 60 项授权专利，是 70 余项标准的共同作者。他是多个期刊与专刊的编辑，多个国际会议的大会主席、技术程序委员会主席或研讨会主席，同时也是多个国际标准组织的主席。他是 NAI 会士、AAAS 会士、IET 会士、IEEE 杰出讲师、奥地利科学院院士。他获得了多项荣誉，包括 IET 成就奖章、IEEE 车载技术学会技术成就奖（Evans Avant-Garde 奖章）、IEEE 通信学会 Edwin Howard Armstrong 奖章、IEEE 通信技术领域奖章、Eric Sumner 奖章。

Andreas F. Molisch received the Dipl.Ing., Ph.D., and Habilitation degrees from the Technical University Vienna, Austria, in 1990, 1994, and 1999, respectively. He spent the ten years in industry, at FTW, AT&T (Bell) Laboratories, and Mitsubishi Electric Research Labs (where he rose to Chief Wireless Standards Architect). In 2009, he joined the University of Southern California (USC), Los Angeles, CA, USA, as a Professor, and founded the Wireless Devices and Systems (WiDeS) Group. In 2017, he was appointed to the Solomon Golomb-Andrew and Erna Viterbi Chair. His research interests include revolve around wireless propagation channels, wireless systems design, and their interaction. Recently, his main interests have been wireless channel measurement and modeling for 5G and beyond 5G systems, joint communication-caching-computation, hybrid beamforming, UWB/TOA-based localization, and novel

modulation/multiple access methods. Overall, he has authored or cauthored four books (among them the textbook Wireless Communications, currently in its second edition), 21 book chapters, 260 journal articles, and 360 conference papers. He is also the Inventor of 60 granted (and more than 20 pending) patents, and co-author of some 70 standards contributions. Dr. Molisch is the Editor of a number of journals and special issues, General Chair, Technical Program Committee Chair, or Symposium Chair of multiple international conferences, and also Chairman of various international standardization groups. He is a Fellow of the National Academy of Inventors, Fellow of the AAAS, Fellow of the IET, an IEEE Distinguished Lecturer, and a Member of the Austrian Academy of Sciences. He was the recipient of numerous awards, among them the IET Achievement Medal, the technical achievement awards of IEEE Vehicular Technology Society (Evans Avant-Garde Award) and the IEEE Communications Society (Edwin Howard Armstrong Award), and the Technical Field Award of the IEEE for Communications, Eric Sumner Award.

Harald Haas 是英国思克莱德大学移动通信杰出教授、爱丁堡大学访问教授、LiFi 研发中心主任，也是 pureLiFi 公司的发起人、共同创始人以及首席科学家。2001 年在英国爱丁堡大学获博士学位。已发表超过 600 篇期刊及会议论文，2017-2021 年入选全球高被引科学家。研究兴趣包括光无线通信以及他于 2006 年首次提出的空间调制。2016 年获国际半导体照明联盟杰出成就奖。2019 年获 IEEE 车载技术学会 James Evans Avant Garde 奖章。2017 年获皇家学会 Wolfson 研究优胜奖。2021 年获 Enginuity The Connect Places 创新奖。他是 IEEE Fellow、英国皇家工程院院士、英国爱丁堡皇家学会院士、IET Fellow。

Harald Haas is a Distinguished Professor of Mobile Communications at The University of Strathclyde/Glasgow, Visiting Professor at the University of Edinburgh and the Director of the LiFi Research and Development Centre. Prof. Haas set up and co-founded pureLiFi. He currently is the Chief Scientific Officer. He received the Ph.D. degree from The University of Edinburgh in 2001. He has authored 600 conference and journal papers. He has been among the Clarivate/Web of Science highly cited researchers between 2017-2021. Haas's main research interests are in optical wireless communications and spatial modulation which he first introduced in 2006. In 2016, he

received the Outstanding Achievement Award from the International Solid State Lighting Alliance. He was the recipient of IEEE Vehicular Society James Evans Avant Garde Award in 2019. In 2017, he received a Royal Society Wolfson Research Merit Award. He was the recipient of the Enginuity The Connect Places Innovation Award in 2021. He is a Fellow of the IEEE, the Royal Academy of Engineering (RAEng), the Royal Society of Edinburgh (RSE) as well as the Institution of Engineering and Technology (IET).

种稚萌分别于 2002、2005、2008 年获西安交通大学电子工程专业学士、硕士、博士学位。他 2009 年加入华为，有 11 年的无线通信系统研发经验。种博士是 IEEE 高级会员。他主要研究无线信道测量、信道建模、MIMO 算法与系统设计。他是华为无线信道研究的团队负责人。特别地，他负责华为 3GPP 5G 信道模型标准化工作，在 3GPP 毫米波信道模型、V2V 信道模型、IIoT 信道模型标准化方面做出贡献。今年他主要研究基于信道特性的大规模天线算法设计和机器学习技术。

Zhimeng Zhong received the B.E., M.S., and Ph.D. degrees from Xi'an Jiaotong University, Xi'an, China, in 2002, 2005, and 2008, respectively, all in electronic engineering. He joined Huawei Technologies CO., LTD from 2009, and about 11 years experiences on wireless communication system research and development. Dr. Zhong is a senior member of the IEEE. In these years, he mainly focused on wireless channel measurement, channel modelling, and MIMO algorithm & system design. He is the team leader of wireless channel research in Huawei. Especially, he was in charge of the 3GPP 5G channel model standardization work in Huawei, and gave contributions on 3GPP mm-wave channel model, V2V channel model, and IIoT channel model standardization. Recently, he also focused on massive MIMO algorithm design based on some special channel characteristics and machine learning technologies.

2.3. Frontiers of Microwave, Millimeter-wave and Terahertz Technologies (微波、毫米波与太赫兹前沿技术)

This course introduces the fundamental knowledge and application of microwave, millimeter-wave and terahertz techniques, as well as their recent developments. Specially, the following contents are introduced in detail: the basic knowledge of electromagnetic equations and electromagnetic waves; microwave network and its applications; electromagnetic guided-wave theory and its applications, as well as its applications in the advanced filter design; microwave and millimeter-wave techniques in the next-generation satellite and 5G/6G communication systems; function-integrated passive devices and antennas; new manufacturing techniques for millimeter-wave and terahertz components, as well as microwave and millimeter-wave filters based on additive manufacturing; high-power microwave technologies for satellite applications; basic knowledge of radar system: advanced phased array radar technology and its recent development. This course helps students master the basic knowledge of microwave, millimeter-wave and terahertz technology, understand their applications, and establish the “field” concept of microwave technology.

2.3.1. 教学日历

时间 Time	节数 Class	课程内容 Content	授课教师 Lecturer	授课平台 Platform
4-Jul 15:50-17:25	C8-C9	Fundamental Equations of Electromagnetic Waves and Their Applications (Unit 1A)	Prof. Jia-Sheng Hong	271-899-304
5-Jul 15:50-17:25	C8-C9	Fundamental Equations of Electromagnetic Waves and Their Applications (Unit 1B)	Prof. Jia-Sheng Hong	266-358-558
6-Jul 15:50-17:25	C8-C9	Microwave Network and Applications (Unit 2A)	Prof. Jia-Sheng Hong	435-835-904
8-Jul 18:30-20:05	C11-C12	Microwave Network and Applications (Unit 2B)	Prof. Jia-Sheng Hong	506-564-301
11-Jul 18:30-20:05	C11-C12	Guide-Wave Techniques and Fundamental Theories of Filters (Unit 3A)	Prof. Jia-Sheng Hong	496-269-343
12-Jul 15:50-17:25	C8-C9	Guide-Wave Techniques and Fundamental Theories of Filters (Unit 3B)	Prof. Jia-Sheng Hong	128-266-171

13-Jul 15:50-17:25	C8-C9	Microwave and Miliimeter-wave Techniques in the Next Generation Satellite and 5G/6G Communication Systems (Unit 4A)	Prof. Jia-Sheng Hong	868-724-169
14-Jul 15:50-17:25	C8-C9	Microwave and Miliimeter-wave Techniques in the Next Generation Satellite and 5G/6G Communication Systems (Unit 4B)	Prof. Jia-Sheng Hong	499-247-102
16-Jul 15:50-17:25	C8-C9	Function-Integrated Passive Devices and Antennas – Point of View from Filter Design	Prof. Yi Wang	247-640-835
18-Jul 15:50-16:35	C8	Microwave and Millimetre-Wave Filters based on Additive Manufacturing	Prof. Yi Wang	627-645-459
18-Jul 16:40-17:25	C9	New Manufacturing Techniques for Millimetre-Wave and Terahertz Components	Prof. Yi Wang	627-645-459
23-Jul 14:00-17:25	C6-C9	High-Power Microwave Technologies for Satellite Applications	Prof. Wan-Zhao Cui	398-581-263
24-Jul 14:00-17:25	C6-C9	Introduction of Radar Techniques and Relative Theory	Dr. Hong-Chao Wu	217-808-269
30-Jul 14:00-17:25	C6-C9	The Modern Phase-Array Radar and its Key Techniques	Dr. Hong-Chao Wu	505-107-848

2.3.2. 外教介绍

Jiasheng Hong 教授， 1994 年毕业于英国牛津大学工程与科学学院，获得博士学位。攻读博士学位期间，主要从事电磁理论与应用的研究。1994 年，他工作于英国伯明翰大学，从事高温超导微波技术、电磁建模理论和电磁优化方法的研究。2001 年，他工作于英国赫瑞瓦特大学电子、电气和计算机学院并担任教授职位。Jiasheng Hong 教授正带领团队从事关于射频/微波器件和设备的先进技术研究。他已发表专业论文 200 余篇，并已撰写四本在领域内具有很大影响力的经典著作：*Microstrip Filters for RF/Microwave Applications* (Wiley, 1st ed., 2001, 2nd ed., 2011), *RF and Microwave Coupled-Line Circuits* (Artech House, 2nd ed., 2007), *Balanced Microwave Filters* (Wiley, 2018), and *Advances in Planar Filters Design* (The Institution of Engineering and Technology (IET), 2019)。Jiasheng Hong 教授的主要研究领域包括：无线通信和雷达系统中的射频/微波器件，如天线、滤波器等；新型材料、工艺及其微波/射频器件，如多层液晶高分子聚合物微波毫米波电路、多层低温共烧陶瓷微波毫米波电路、增材和 3D 打印微波毫米波电路、射频 MEMS 电路、铁电和高温超导微波毫米波器件等。

Jiasheng Hong 教授是 IEEE Fellow，担任 IEEE 微波理论与技术学会滤波器、无源元件和微波超导技术委员会委员、国际权威期刊 IET Electronics Letters 领域主编（微波技术）、国际权威期刊 IET Microwaves, Antennas & Propagation 副主编、国际期刊 International Journal of RF and Microwave Computer Aided Engineering 副主编，曾担任领域顶级期刊 IEEE Transactions on Microwave Theory and Techniques 副主编。Jiasheng Hong 教授现为英国高等教育学院院士。

Jiasheng Hong received the D.Phil. degree in engineering science from the University of Oxford, Oxford, U.K., in 1994. His doctoral dissertation concerned EM theory and applications. In 1994, he joined the University of Birmingham, Birmingham, U.K., where he was involved with microwave applications of high-temperature superconductors, EM modelling, and circuit optimization. In 2001, he joined the Department of Electrical, Electronic and Computer Engineering, Heriot-Watt University, Edinburgh, U.K., and is currently a Professor leading a team for research into advanced RF/microwave device technologies. He has authored and coauthored over 200 journal and conference papers in this field, and has published four relevant books - *Microstrip Filters for RF/Microwave Applications* (Wiley, 1st ed., 2001, 2nd ed., 2011), *RF and Microwave Coupled-Line Circuits* (Artech House, 2nd ed., 2007),

Balanced Microwave Filters (Wiley, 2018), and *Advances in Planar Filters Design* (The Institution of Engineering and Technology (IET), 2019). His current interests involve RF/microwave devices, such as antennas and filters, for wireless communications and radar systems, as well as novel material and device technologies including multilayer circuit technologies using package materials such as LCP and LTCC, Additive manufacturing or 3D printing device technologies, RF MEMS, ferroelectric, and high-temperature superconducting devices.

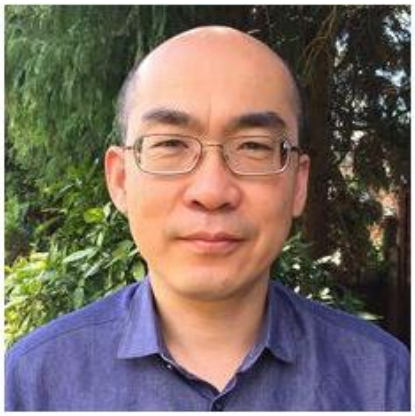
Professor Hong is a Fellow of IEEE, a member of the IEEE MTT Technical Committees of Filters and Passive Components and Microwave Superconductivity, the Subject Editor (Microwave) for Electronics Letters, an Associate Editor of IET Microwaves, Antennas & Propagation and International Journal of RF and Microwave Computer Aided Engineering. He was also a past Associate Editor of IEEE Transactions on Microwave Theory and Techniques. Professor Hong is a Fellow of the Higher Education Academy, UK.

吴鸿超，研究员，2006 年毕业于东南大学无线电系电磁场与微波技术专业，博士学历，现为中国电子科技集团公司第十四研究所天线与微波部室主任，主要从事有源相控阵天线研制，具有丰富的经验，发表论文和专利等十余篇。曾作为负责人，牵头研发了某舰载 X 波段相控阵雷达天线阵面和某大型机动式情报雷达天线阵面，曾获国防科技进步二等奖、江苏省“333”人才等荣誉称号。

Hongchao Wu, received the Ph.D. degree in radio engineering from Southeast University, Nanjing, China, in 2006. He is the director of antenna and microwave Department of the 14th Research Institute of China Electronics Technology Group Corporation. His research focus on the active phased array antenna. As a principal investigator, he leads a research team of around 100 researchers, and developed successfully of a shipborne X-band phased array radar and a large mobile intelligence radar antenna array for defense applications. He has published more than ten papers and patents. He receipts the second prize of national defense science and technology progress award, and "333" talent of the Jiangsu Province, China.

崔万照：博士、研究员、博士生导师，入选国防高层次人才、国务院政府特殊津贴获得者、陕西省高层次人才特殊支持计划专家、中国空间技术研究院首席研究员、航天科技集团有限公司卫星通信方向学术带头人、航天科技集团有限公司科技创新团队带头人。先后获航天贡献奖、陕西国防工业十大创新标兵、中国电子学会优秀科技工作者、中国航天基金奖、航天五院创新奖等荣誉称号，获省部级奖项 6 项，申请授权和受理发明专利 50 多项，发表学术论文 200 多篇，出版中英文专著/编著/译著 10 多部。

Wanzhao Cui，received the Ph.D. degree in electrical engineering from Xi'an Jiaotong University, Xi'an, China, in 2006. Since 2006, he has been with China Academy of Space Technology, Xi'an, where he has been the Vice-Director of the National Key Laboratory of Science and Technology on Space Microwave since 2008. Since 2012, he has been a Professor with the China Academy of Space Technology, Xi'an. His current research interests include microwave technology, and satellite communication. He has more than 150 publications, 54 issued invention patents, 31 authorized patents, authored and translated 10 books.



王奕，博士，英国伯明翰大学工程学院电子电气工程系副教授，博士生导师，微加工和太赫兹测量实验室主任，Emerging Device Technology 研究组负责人。曾就职英国格林威治大学工程科学系，任副教授。2001 年获英国国际研究生奖学金和工程学院奖学金资助，师从微波器件和滤波器理论专家 Michael J. Lan-caster 教授，2005 年获电子工程博士。2004-2011 年在伯明翰大学先后任副研究员和研究员，负责英国工程和物理科学研究基金项目，管理微波毫米波及低温微波测量实验室。2017 年被聘为中科院上海硅酸盐研究所兼职教授。王奕

博士在微波和太赫兹天线和器件领域有近二十年丰富的研究经历，诸多工作处于工程和材料的交叉领域。主要运用新型材料和微加工技术，结合新型微波设计理念和方法，研制微波和太赫兹天线、器件以及系统。王奕博士的研究主要受到英国工程和物理科学研究基金，欧盟地平线计划、欧洲航天局、中国自然科学基金海外学者基金以及工业界的资助。王奕博士发表学术论文 200 余篇，包括 120 篇期刊论文。他担任多个国际著名期刊的评审。王奕博士是电气电子工程师学会高级会员、英国高等教育学会会士和英国工程和物理科学研究基金评委，多个国际会议的技术委员会主席并参与多个国际会议的组织工作。

Yi Wang is an Associate Professor in the Department of Electrical and Electronic Engineering, School of Engineering, University of Birmingham, U.K. He is currently the Director of the Microfabrication and Terahertz Measurement Laboratory and Head of the Emerging Device Technology Research Group at the University of Birmingham. He was previously an Associate Professor in the Department of Engineering Science at the University of Greenwich, U.K. He was awarded a UK International Postgraduate Scholarship and a School of Engineering Scholarship in 2001 to study with Professor Michael J. Lancaster, an expert in microwave devices and filter theory, and received his Ph.D. in Electrical Engineering in 2005. He was appointed as an Adjunct Professor at the Shanghai Institute of Silicate, Chinese Academy of Sciences in 2017. Dr. Yi Wang has nearly two decades of extensive research experience in microwave and terahertz antennas and devices, with much of his work at the intersection of engineering and materials. He has been working on microwave and terahertz antennas, devices and systems using novel materials and micro-fabrication techniques combined with new microwave design concepts and methods. Dr. Wang's research has been supported by the UK Engineering and Physical Sciences Research Council, the Program of Horizon Europe, the European Space Agency, the Joint Research Fund for Overseas Natural Science of China, and Industry. Dr. Wang has authored more than 200 research papers, including 120 journal articles. He has served as a reviewer for several prestigious international journals and has given more than ten invited presentations and lectures since 2014. Dr. Wang is a Senior Member of the Institute of Electrical and Electronics Engineers, a Fellow of the Higher Education Academy, a Judge of the UK Engineering and Physical Sciences Research Council, TPC Chairs of several international conferences and participates in the organization of several international conferences.

3. 课程总结及反馈

由于疫情影响，课程主要采用线上方式进行教学，充分利用多媒体的优势增大信息含量，也便于更新和展示本专业领域的前沿成果，更多地和学生进行交流和互动，通过提高学生的参与积极性和教学效果。学生反映，授课教师非常细心地讲解专业知识，每节课都能学习到很多新的东西。虽然上课的强度很大，但是会根据学生的接受程度调整语速，引人入胜、深入浅出。全英文授课也有助于提高英语听说能力，掌握英语专业词汇，提升科研文献阅读能力。同时，还会结合日常生活、军事、医疗等方面的应用，反应前沿技术对于人类社会的促进作用。针对课程要点，任课教师布置了 MATLAB 等编程作业，将学生实践动手能力的培养融入教学过程。譬如，通过实验逐步完成简单的衰落信道建模过程，让学生在掌握编程技巧的同时，更好地理解随机过程、相关函数、瑞利分布、莱斯分布等一系列重要概念。此外，还针对每门课程的特点，以撰写英文课程报告为目标，让学生对感兴趣的主题进行调研，了解该研究方向的最近进展与未来挑战，为以后的科研及学术写作打下基础，取得了较为显著的效果。譬如，吴健雄学院的赵舞穹同学利用课程所学知识，独立撰写了一篇毫米波信道建模与信道估计方面的论文。