**Global Education and Training**

**University of Illinois Urbana-Champaign**

**Summer 2021**

**Undergraduate Summer School**

**Telecommunications and Engineering (3 weeks)**

**Introduction**

Global Education and Training’s Telecommunication and Engineering Undergraduate Summer School (T&E USS) at the University of Illinois at Urbana Champaign offers students a foundational and forward-looking introduction to Wireless and Mobile communications from Algorithms and system design to Applications.

5G networks and cloud-based computing are vital applications in the development of Internet of Things (IoT), and these technologies are central to the evolving IoT that is revolutionizing industry, personal lives, and virtual reality. IoT innovations are making technology more accessible, secure, and smarter. Learn more about these emergent technologies from Illinois’ expert faculty, who will lead students in a live online classroom space.

The T&E USS will help students understand mathematical concepts and algorithms deployed in wireless applications. Illinois’ leading faculty will engage students in lecture discussions on core mathematical principals, systems design, and real-world applications. Students are expected to participate in live discussions and problem solving during each live class session. Courses are self-contained with fundamental algorithms to leading research in digital communications. These courses will prepare students for the next phase in their education, and career.

**T&E USS Courses**

**Wireless and Mobile IoT: From Algorithms to Applications (5 hours)**

This course will help students develop essential foundations for wireless networking, mobile computing, and IoT systems. The goal of this course is to balance mathematical algorithms and real-world applications. The course takes on various real applications (e.g., 5G, Amazon Alexa, AR/VR, autonomous cars, GPS, etc.), break them up into technical problems to learn how various algorithms can be applied and solved systematically. Through this process, students will learn algorithms and also appreciate how practical issues often require creativity and engineering.

**Proposed Syllabus:**

- Foundations: Linear algebra, Digital Signal Processing (DSP), Communications, Probability

- GPS localization: trilateration, triangulation

- Indoor localization: beamforming, sub-space techniques

- Motion tracking: IMU sensors, dead reckoning

- Gesture recognition, AR/VR: HMM, Viterbi, Particle filter

- Wireless motion sensing: FMCW, Doppler

- Amazon Alexa: Dynamic time warping, mixture models, expectation-maximization

- Security, privacy: non-linear attacks

**Wireless and Mobile IoT Instructor:**

*Romit Roy Choudhury, Professor of Electrical and Computer Engineering*

[*https://ece.illinois.edu/about/directory/faculty/croy*](https://ece.illinois.edu/about/directory/faculty/croy)

**Wireless Communications: 5G / WiFi 6 & Low Power IoT Communication (5 hours)**

The goal of this course is to teach students the fundamentals of wireless communications from basic principles to the current standards for 5G cellular networks, WiFi 6, and Low Power IoT Communication. The course would take a practical system approach to break up the technical components of a wireless communication system both in terms of analog hardware, digital processing, and software. Students will learn the components of an end-to-end wireless communication system including amplifiers, mixers, AGCs, up and down-conversion, pulse shaping, synchronization, modulation, channel equalization, carrier recovery, etc. The course also covers techniques used in the latest communication systems like 5G, Wi-Fi 6, and IoT. These include OFDM, MIMO, Multi-user MIMO, Beamforming, Millimeter Wave, OFDMA, Backscatter communication, Spread Spectrum Communication, Bluetooth, LoRA, etc. The course combines core mathematical principles with practical system design.

**Proposed Syllabus:**

- Components of Digital Communication Transceiver.

- Up/Down Conversion, Pulse Shaping & Matched Filters, Symbol Timing Recovery.

- Modulation: Coherent, Non-Coherent Modulation, BER vs. SNR

- AGCs, Amplifiers, ADCs, DACs & Quantization.

- Wireless channel characteristics and Channel Equalization.

- Carrier Recovery, CFO estimation and correction, Phase Tracking.

- Orthogonal Frequency Division Multiplexing: OFDM

- Software Defined Radios

- 5G & Millimeter Wave Communication

- WiFi 6 & OFDMA

- Bluetooth & Spread Spectrum Communication

- IoT LoRA based communication

- IoT Backscatter based Communication

**Wireless Communications Instructor:**

*Haitham Al-Hassanieh, Assistant Professor of Electrical and Computer Engineering*

[*https://ece.illinois.edu/about/directory/faculty/haitham*](https://ece.illinois.edu/about/directory/faculty/haitham)

**Reading Week Sessions (4 hours):**

To prepare for professor lectures, students will be assigned and receive reading materials during the Orientation Week. Students will complete these readings on their own outside of class. Students will then meet in live sessions during the reading week with University of Illinois teaching assistants (TAs). The TAs will guide the students’ understanding of the topics by highlighting key points from the readings and answering students’ questions.

**Co-Curricular Sessions: (4 hours)**

Students will attend guest speaker/panelist sessions with University of Illinois Ph.D. students and alumni. Topics may include: applications and admissions process for graduate studies; writing a personal statement; conducting research as a doctoral student; keys to a successful engineering career; and more. The overall program will conclude with a learning outcome showcase and a program recognition ceremony led by University of Illinois staff.

**Online Program Format**

The program will be conducted primarily as synchronous videoconference meetings, with coursework assignments completed asynchronously. It is anticipated that videoconference classes will be conducted using Zoom and using the University of Illinois' course management system. Course materials will be accessible to program participants one week before the starting of the program. An orientation session will be host by GET staff before the starting of the program.

**Draft Weekly Schedule**

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| Week Overview | Activity | Duration (50 minutes) |
| Orientation Week | Technology Testing | 1 |
| Orientation | 1 |
| Co-curricular session | 1 |
| Reading Week: Week 1 | TA-led discussions | 4 |
| Co-curricular session | 1 |
| Lecture Week: Week 2 | Wireless and Mobile IoT: From Algorithms to Applications | 5 |
| Wireless Communications:  From 5G and WiFi 6 to Low Power IoT Communication. | 5 |
| TA-led Q&A | 5 |
| Final Project Week: Week 3 | Co-curricular session | 2 |
| TA-led Q&A | 2 |
| Final Presentations | 2 |
| Program Recognition | 1 |
| Total: | | 30 hours |

**Technology Requirements**

Participants should have access to Wi-Fi and a device (computer, laptop, or tablet) suitable for participation in online videoconference sessions. Participants may connect to the class sessions from their own home or another location with Wi-Fi, such as a university office.

**Cost for 3 weeks online program:**

**Program fee: $800.00** per person\*

Program fee includes tuition for development and instruction of online courses; assessment (grading) of participant performance in courses; online Learning Management System and videoconference system licensing; and university support fees.

\*Minimum of 50 participants.

**For questions or more information contact:**

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