# Communications and Signal Processing

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# School of Electrical Computer and Energy Engineering (ECEE)



**ecee.engineering.asu.edu/academics/**

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# What is Signal Processing?

*Video Compression*

*Audio Coding MP3*

*iPod*

**Active Noise Cancellation**

**iPhone DSP apps**

**Biometric ID Verification**

**Array Signal Processing**

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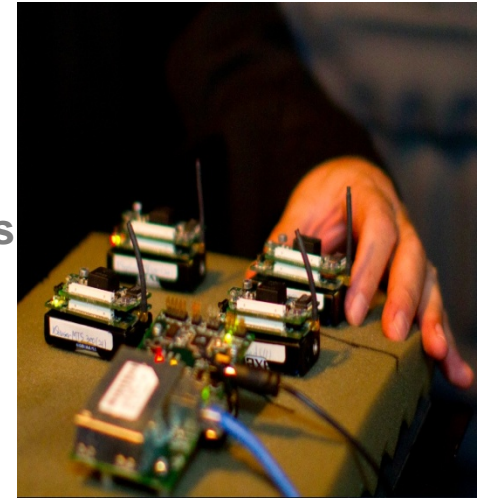
# Biomedical Signal Processing?



**DSP for Speech And Hearing**

*Biomedical Signal Processing*

**DSP And Sensors**

**DSP for Health Monitoring**
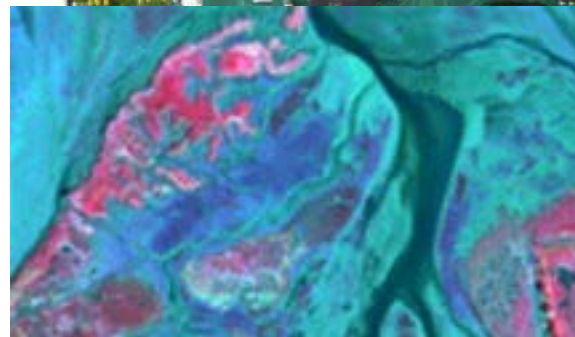
*Hyper-spectral Imaging*

*DNA Sequence Analysis using DSP Methods*

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# What is Communication?

**Data Networking**

**Satellite Communications**
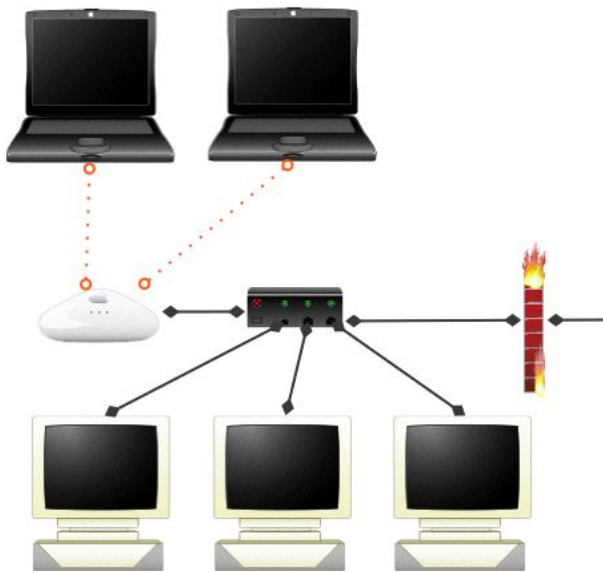


**Cellular Telephony**

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# Military Applications …
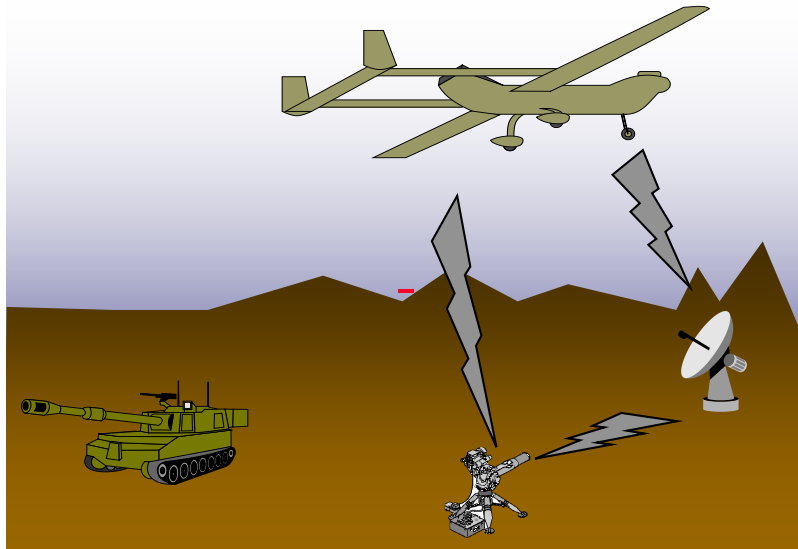


**Automatic Target Recognition**

**Sensor Networks**



**Target Imaging**

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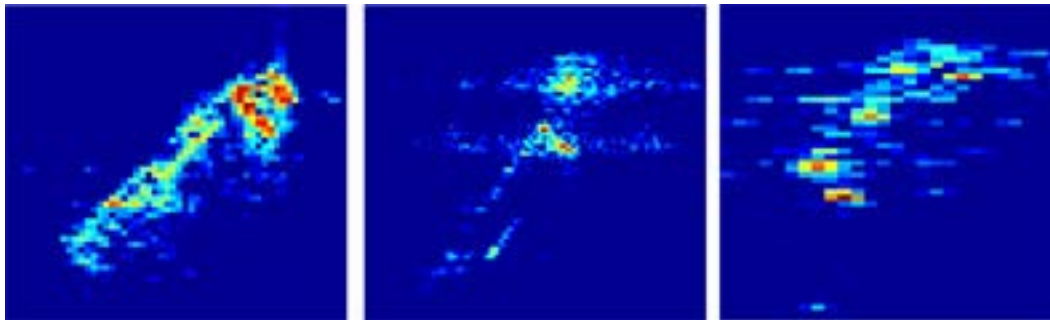
# Smart Grid Network Applications…

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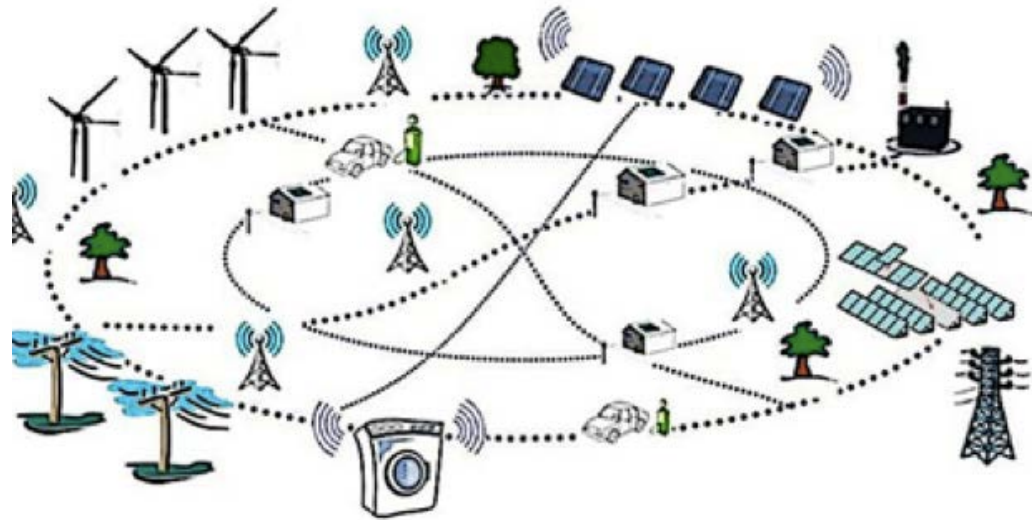
# … to Applications in the Arts



*Ambiguous Icons*
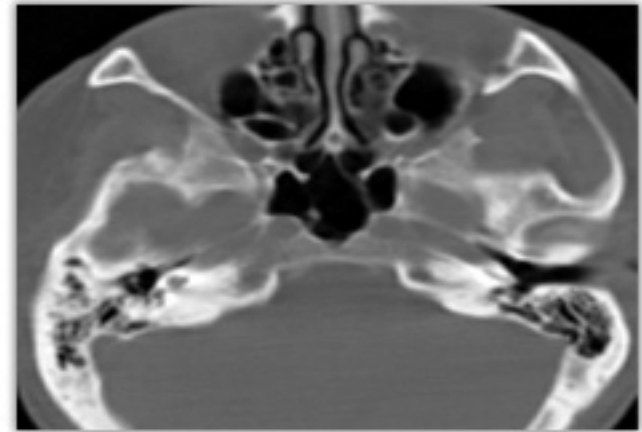


*Body Sensing Technologies*



*Interactive Performance*

**AME Concentration**

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# COURSES
## Junior Level "Lead-in" Courses

- **EEE 203 – Signals and Systems I**
  - **Introduction to linear systems and Fourier transform analysis**

- **EEE 304 – Signals and Systems II**
  - **Theory and Applications of linear systems in Communications, Controls, and Signal Processing**

- **EEE 350 – Random Signal Theory**
  - **Introduction to probability and stochastic processes**

- **EEE 203 and 350 are representative of the things you need to know**

- **They are prerequisites to some senior level courses**

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# COURSES
## Senior Electives

- ## EEE 407 – Digital Signal Processing
  - *Fundamentals* of digital signal processing-time and frequency domain analysis, FFT, filter design

- ## EEE 455 – Communications Systems
  - *Fundamentals* of communication systems-digital and analog modulation, receiver design, noise

- ## EEE 459 – Communications Networks
  - Communications network architectures, transmission protocols, seven-layer OSI stack

- ## EEE 404 – Real Time DSP
  - *Usually students will take after EEE 304 or 407*
  - Course covers programming of DSP algorithms

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# Sample MSE Plan of Study
# Signal Processing

**Proposed Graduate Program**

| | Course Number | Course Title | Semester Hours | Semester/Year | Grade |
|---|---|---|---|---|---|
| 1 | EEE 591 | DIGITAL SIGNAL PROCESSING | 3 | FALL | |
| 2 | EEE 591 | COMMUNICATION SYSTEMS | 3 | FALL | |
| 3 | EEE 554 | RANDOM SIGNAL THEORY | 3 | FALL | |
| 4 | EEE 506 | DIGITAL SPECTRAL ANALYSIS | 3 | SPRING | |
| 5 | EEE 552 | DIGITAL COMMUNICATIONS | 3 | SPRING | |
| 6 | EEE 508 | IMAGE/VIDEO CODING | 3 | SPRING | |
| 7 | EEE507 | MULTI-D SIGNAL PROC | 3 | FALL | |
| 8 | EEE 505 | TIME FREQUENCY SP | 3 | FALL | |
| 9 | EEE 606 | ADAPTIVE SIGNAL PROC | 3 | FALL | |
| 10 | EEE 607 | SPEECH CODING | 3 | SPRING | |

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# Sample MSE Plan of Study Communications/Networks

**Proposed Graduate Program**

| | Course Number | Course Title | Semester Hours | Semester/Year | Grade | |
|---|---|---|---|---|---|---|
| 1 | EEE 591 | Communication Networks | 3 | FALL | | |
| 2 | EEE 591 | Communication Systems | 3 | FALL | | |
| 3 | EEE 554 | Random Signal Theory | 3 | FALL | | |
| 4 | EEE 551 | Information Theory | 3 | SPRING | | |
| 5 | EEE 552 | Digital Communications | 3 | SPRING | | |
| 6 | EEE 553 | Coding and Cryptography | 3 | SPRING | | |
| 7 | EEE 557 | Broadband Networks | 3 | FALL | | |
| 8 | EEE 558 | Wireless Communications | 3 | FALL | | |
| 9 | EEE556 | Detection and Estimation | 3 | FALL | | |
| 10 | EEE 598 | Wireless Networks | 3 | Spring | | |

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# Direct Ph.D. POS

**Direct Includes**
- **30 hours of MS level courses**
- **+18 hours for PhD level courses**
- **+Research Credits**
- **+Dissertation Credits**

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# Career Opportunities

*What do signal processing and communications engineers do?*

- **Signal Enhancement:** noise reduction, music and image restoration, high resolution imaging

- **Signal Compression:** speech, image, video, biomedical data

- **Pattern Recognition:** speech recognition, biometric identification, target recognition, machine learning

- **Cellular Systems:** system design, performance analysis, equipment design and manufacturing

- **Satellite and Terrestrial Microwave Systems:** modem design and implementation, system design, performance analysis

- **Networking:** network design and implementation, Network security, equipment design and manufacturing.

- **Algorithm Design:** software and hardware implementations, data mining

- **Hardware Design:** architectures, DSP chips, application specific IC's

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# Career Opportunities

*Some Potential Employers*

| Motorola | AT&T | Qualcomm | Intel |
|---|---|---|---|
| Medtronics | Raytheon | Cisco | Xerox |
| MRC | HP | Agilent | Lucent |
| Nokia | Samsung | Lockheed Martin | |
| IBM | Texas Instruments | Boeing | |
| Qwest | General Dynamics | Spectrum Astro | |
| Freescale | National Instruments | Broadcom | |
| EF Data | LG Electronics | Sprint | |
| Government | Universities | | |

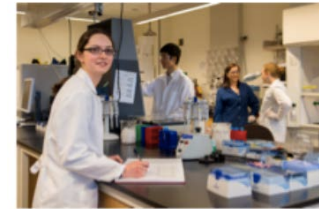*Communications and Signal Processing*

# Graduate School

- **Communication and signal processing fields are advancing rapidly**

- **Companies are looking increasingly towards MS and PhD holders to lead their development teams**
  - **BS just doesn't provide enough expertise**

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# Ph.D. Degrees

**Demand has increased considerably for Ph.D.**

- **Careers in academia**
- **Careers in Industry Research Labs**
- **Careers in Government Labs (graduates in big demand)**
- **Entrepreneurs**

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# Graduate Classes

- **Digital Communications**
- **Wireless Networks / Wireless Communications**
- **Broadband Networks**
- **Network Security**
- **Motion Capture**
- **Spectral Estimation and Array Processing**
- **Coding and Cryptography / Information Theory**
- **Multidimensional Signal Processing**
- **Image and Video Processing**
- **Speech and Audio Processing**
- **Time-Frequency Analysis**
- **Filtering of Stochastic Processes**
- **Detection and Estimation**
- **Adaptive Filters for Equalization and Echo Cancellation**
- **Multimedia Signal Processing**
- **Signal Processing for the Arts**
- **Array Processing**
- **Big Data**

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# Faculty

**Anna Scaglione**, Signal Processing for Communications Networks

**Chaitali Chakrabarti**, Low Power Architectures

**Lalitha Sankar**, Networks, Optical Networks

**Dan Bliss**, Communications, Radar, Biomedical, Sensor Arrays

**Andreas Spanias**, DSP, Speech/Audio Processing, Sensor Arrays

**Douglas Cochran**, Signal Analysis, Sensor Networks

**Lina Karam**, Image/Video Processing and Coding

**Oliver Kosut**, Information Theory, Sensor Networks

**Lei Ying**, Wireless Networks, Big Data

**Yanchao Zhang**, Network Security

**Visar Berisha**, Speech Processing, Machine Learning

**Tolga Duman**, Wireless Communications, Turbo Codes

**Pavan Turaga**, Motion Estimation

**Martin Reisslein**, Networks for streaming data and media

**Antonia Papandreou-Suppappola**, Sensors, Time-Frequency Representations

**Cihan Tepedelenlioglu**, Signal Processing for Communications, Multicarrier

**Junshan Zhang**, Information Theory, Ad-Hoc Networks

**David Frakes**, Bioengineering, Imaging

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# Programmatic Collaborations

- **Co-advisement for M-disciplinary dissertations**
- **Sensor Signal and Information Processing (NSF Industry-University Center)**
- **Arts Media and Engineering (Concentration)**
- **Certificate in Sensors and Signal Processing**
- **Global Security Initiative (GSI)**
- **Biodesign Institute**
- **School of Sustainability**

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# Questions?

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