

# ECE 421: Telecommunication I

IN

OUT

## **ODE and Transfer Functions**

- Can describe key properties of LTI systems
  - Transfer functions
  - Impulse response
  - Complex frequency
- Understands connections between transfer functions, poles and zeros, impulse response, complex frequency response, and ODE

## **Fourier Analysis**

- Can analyze spectral components of periodic inputs and outputs of systems
- Understands complex spectra of aperiodic and periodic continuous time signals
- Can compute transforms for standard pulses

## **Block Diagrams**

- Can determine behavior of a system built of other interconnected linear systems

## **Simulation Analysis**

- Can analyze systems in time and frequency domain using MATLAB and Simulink tools

## **Random Variables**

- Can compute pmf, pdf, cdf, characteristic functions, and moments
- Can compute pdf for functions of independent random variables

## **Pre-requisites:**

- ECE/STAT303 and ECE311

## **Concepts:**

- Modulation:
  - Amplitude modulation (AM)
  - Double sideband modulation (DSB)
  - Single sideband modulation (SSB)
  - Frequency modulation (FM)
  - Phase modulation (PM)
- Demodulation:
  - Envelope detector
  - Costas receiver
  - Quadrature demodulator
  - Phase-locked loop
- Sampling and reconstruction:
  - Sampling theorem
  - Aliasing
- Quantization techniques:
  - Pulse amplitude modulation
  - Pulse-code modulation (PCM)
  - Differential PCM
- Baseband data transmission:
  - Inter-symbol interference
  - Equalization
- Digital band-pass modulation:
  - Amplitude-shift keying
  - Frequency-shift keying
  - Phase-shift keying
- Noise in communication systems:
  - Signal to noise ratio analysis

## **Applications:**

- Digital communications
- Channel modeling
- Information transmission
- Estimation and detection

## **Bandwidth Analysis**

- Can analyze the bandwidth of a communication system with analog modulation schemes, including AM, DSB, SSB, FM and PM schemes

## **Sampling and Quantization**

- Understands Nyquist sampling rule and the effect of sampling in the frequency domain
- Can analyze quantization error and bit rate of a uniform quantizer
- Understands the design concerns of advanced quantizers in the context of joint quantization and modulation design

## **Equalization and Modulation**

- Understands symbol waveform design for inter-symbol interference avoidance
- Understands key parameters of an eye diagram.
- Can design a zero-forcing equalizer
- Understands the basic baseband and passband modulation schemes such as PAM, PCM, ASK, PSK, FSK
- Can compute error probability for a digital communication system

## **Basic Digital System**

- Can follow the basic diagrams to design a standard digital communication system to deliver a continuous-time signal waveform from a transmitter to a receiver

## **Random Signals and Noise**

- Understands basics of random signals and noise
- Can analyze signal to noise ratio of an analog-modulated communication system