ECE 331: Electronics Principles I

IN

Differential and Integral Calculus

- Integrate and differentiate sinusoidal, exponential and logarithmic functions
- Compute terms of a Taylor series expansion
- Evaluate functions at limiting values

Phasors, Impedance

- Convert complex numbers from Cartesian-to-polar coordinates
- Analyze first- and second-order circuits with Laplace transform

Kirchhoff's Law

- Analyze circuits with reactive and resistive elements
- Use mesh and node analysis to analyze circuits with independent and dependent sources

Thevenin and Norton Equivalent Circuits

- Transform linear circuits with multiple sources and impedances to equivalent Thevenin & Norton forms
- Use equivalent forms to analyze circuit behavior

Intro Lab and Measurement Procedures

- Use instruments including Analog Discovery module
- Measure voltage, current and frequency response in RLC circuits
- Write a multi-section lab report

Bode Plot Nomenclature and Conventions

- Express transfer functions of single and multiple time constant circuits in Bode format

Pre-requisites

- (ECE 202 with a C or higher; MATH 340 with a C or higher; PH142 with a C or higher; ECE 311, may be taken concurrently; ECE 341, may be taken concurrently) or (ECE 202 with a C or higher; MATH 340 with a C or higher; PH142 with a C or higher; ECE 311, may be taken concurrently;ECE451 or ECE528 or CS356, may be taken concurrently)

Concepts:

- Basic semiconductor physics concepts for transistor operations
- Asymmetric, non-linear devices are modeled in terms of region of operation, and parasitic properties:
  - pn junction diodes
  - Zener diodes
  - MOSFETs
  - Bipolar junction transistors
- Region of operation and bias for best performance.
- Transfer functions
- Equivalent circuits
- Single transistor circuit configurations
- Introduction to amplifier circuit feedback
- Impact of operational amplifier non-idealities including input bias current, input voltage offset, and finite gain.

Applications:

- Voltage, current and power supply design
- Large-signal processing (clamps, logic inverters)
- Linear signal processing (linear amplifiers, filters)
- Single-stage, single-transistor amplifier circuits

Tools:

- SPICE
- Electronic circuit editor
- Cadence schematic and simulation tools

OUT

Analysis and Design Using Models

- Express diode, MOSFET and BJT regions of operation

Device Behavior in Circuits

- Determine region of operation, bias points
- Determine equivalent circuits for any region

Linear Signal Amplification, Transfer Functions

- Depict common gate, drain, and source configurations
- Analyze circuits' voltage, and current gain
- Analyze circuits' input and output impedance

Non-ideal Op Amp Circuits

- Analyze feedback circuit gain when open-loop op amp gain is finite.
- Determine circuit output voltage in the presence~~s~~ of input bias currents and input voltage offset.

SPICE Simulation

- Analyze systems in time and frequency domain using MATLAB and/or Simulink tools

Laboratory Procedures: Measurement, Analysis, and Reporting

- Connect devices and evaluate bias circuits and time-varying behavior
- Analyze measurements and display results in Bode plots for transfer functions
- Extract device properties (e.g. threshold voltage) from measured data

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