EE 230

Electronic Circuits and Systems

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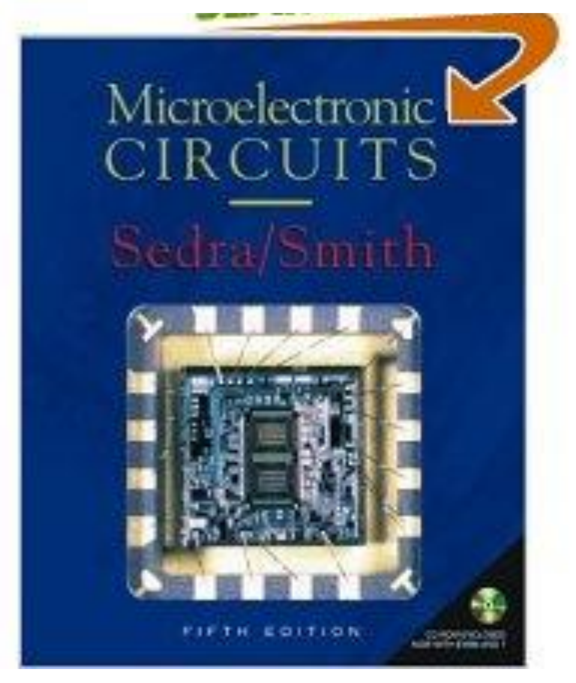
294-7745

Course Description

- Linear Systems
  - Frequency domain characterization of electronic circuits and systems
  - transfer functions
  - sinusoidal steady state response
- Models of linear and nonlinear electronic circuits
  - Linearization
  - small signal analysis
- Stability and feedback circuits
- Operational amplifiers
  - Models
  - linear and nonlinear applications
  - Transfer function realizations.
- Phase-locked Loops
  - Characteristics and applications (if time permits)
- A/D and D/A converters
  - sources of distortions
  - converter linearity and spectral characterization
  - applications

Required Text:

Microelectronic Circuits – Fifth Edition by Sedra and Smith, Oxford, 2004



This text will be heavily augmented with lecture notes

Instructional Approach:

- Emphasis will be placed upon developing and understanding basic concepts and on how basic concepts relate to the much bigger picture
- Lectures will present an alternative approach to material covered in the text
- Testing will attempt to determine if basic concepts are mastered and will generally not be comprised of questions that are minor variants of examples in text, in notes, or in homework problems

Attendance Policy:

- Attendance of class lectures is optional
  - but attendance may be taken
- Turning in of homework is optional
  - but a 0 will be assigned for any missing homework assignments
- Attendance of exams is optional
  - but a grade of 0 will be assigned for any missing exams
- Attendance of any quizzes is optional
  - but a grade of 0 will be assigned for any missing quizzes
- Attendance of all laboratory periods is required
  - and all experiments must be successfully completed and reported to pass the course

Grading Policy:

3 Exams	100 pts each
1 Final	100 pts.
Homework	100 pts.total
Lab and Lab Reports	100 pts.total
Quizzes	15 pts each
Design Project ?	50-100 pts.?

Grade will be assigned based upon total points accumulated

Instructor Access:

- Office Hours
  - Open-door policy
  - to be announced
    - reserved for EE 230 and EE 435 students
  - By appointment
- Email
  - rlgeiger@iastate.edu
  - Include EE 230 in subject

Course Wiki

http:/wikis.ece.iastate.edu/vlsi

A Wiki has been set up for circuits and electronics courses in the department. Links to WEB pages for this course are on this Wiki. Students are encouraged to use the Wiki to share information that is relevant for this course and to access materials such as homework assignments, lecture notes, laboratory assignments, and other course support materials. In particular, there is a FAQ section where issues relating to the material in this course are addressed. Details about not only accessing a Wiki but using a Wiki to post or edit materials are also included on the Wiki itself. Students will be expected to periodically check the Wiki for information about the course.

On the Wiki, you will find

Electronic Circuits and Systems
Spring 2010
COURSE INFORMATION

Room: Lecture - 1227 Hoover
Labs - 2014 Coover

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Time: Lecture - MWF 8:00-8:50
Laboratory
- Sec A Mon 9-11:50 TA:
- Sec B Tues 6:10-9 TA:
- Sec C Wed 9-11:50 TA:
- Sec D Wed 4:10-7 TA:
- Sec E Mon 2:10-5 TA:

Lecture Instructor:

Randy Geiger
2133 Coover
Voice: 294-7745
e-mail: rlgeiger@iastate.edu
Office Hours: Maintains an open-door policy, will reserve 9:00 to 10:00 MWF specifically

Laboratory Instructors and Teaching Assistants:

Yassin Labyed	labyed@iastate.edu
Gunjan Pandey	gpan@iastate.edu
Lei Ke	kelei@iastate.edu

Course Description:

(3-3) Cr. 4. F.S. Prereq: 201, Math 267, Phys 222 Frequency domain characterization of electronic circuits and systems, transfer functions, sinusoidal steady state response. Time domain models of linear and nonlinear electronic circuits, linearization, small signal analysis. Stability and feedback circuits. Operational amplifiers, device models, linear and nonlinear applications, transfer function realizations. A/D and D/A converters, sources of distortions, converter linearity and spectral characterization, applications. Design and laboratory instrumentation and measurements.

Short-term information

- Laboratories will begin this week
- Homework Assignment 1 is posted and is due this Friday
- Class meeting times ?

The

how does it work?

where does it fit in? and

why are we doing it?

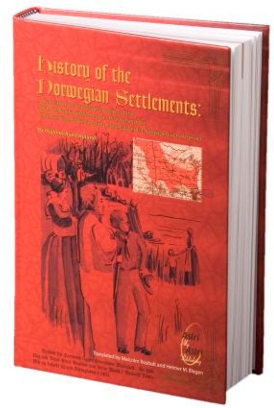
challenge:

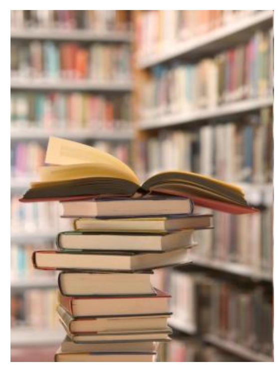
Opportunity depends heavily upon being aware of how existing systems operate and understanding their limitations

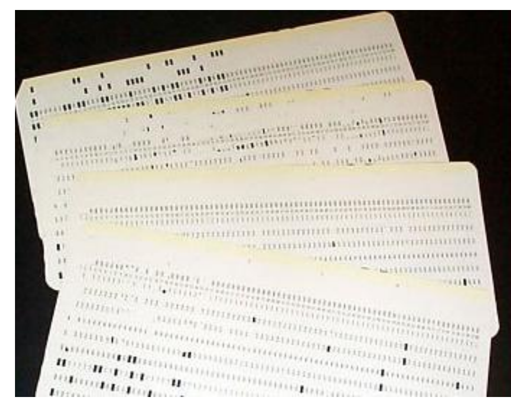
Questions about how existing electronic systems operate or how material presented in the course relates to the electronics field are encouraged.

One of many electronic systems

Data Storage



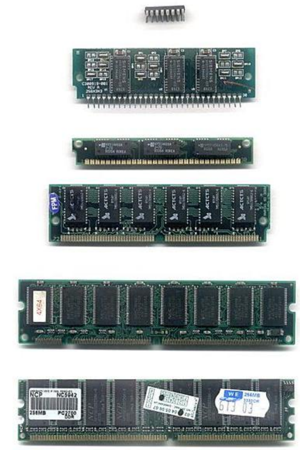


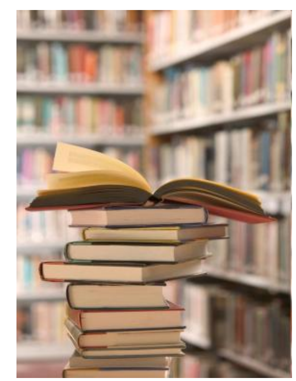


Cost, size, performance tradeoffs

One of many electronic systems

Data Storage





Cost, size, performance tradeoffs

How does the area (size) compare for storing data on CD, DVD, Flash, and Hard Drive?

Cell Phone Policy:

Approximately 1 billion sold in 2009

1997	1998	1999	2000	2001	2002	2003
107.84	175.65	295.15	414.99	413.31	427.37	519.99

2004	2005	2006	2007	2008	2009
674.00	778.75	847.24	914.02	980.29	1,041.52

Source: Gartner Dataquest (July 2005)

Top 15 countries using cell phones

Rank	Country or region	Number of mobile phones	Population	% of population	Last updated
—	World	4,100,000,000	6,768,179,187[1]	60.6	Dec 2008[2]
1	China	720,000,000	1,324,190,000	54.00	Aug 2009[3]
2	India	506,044,156	1,172,756,000	43.15	Nov 2009[4]
3	United States	271,000,000	306,694,000[1]	88.04	Dec. 2008[5]
4	Russia	190,000,000	141,812,991	134	Feb. 2009[6]
5	Brazil	169,800,000	189,985,135	89.37	Nov. 2009[7][8]
6	Indonesia	140,200,000	231,627,000	60.53	Dec. 2008[9]
7	Japan	107,490,000	127,790,000	84.11	Mar. 2009[10]
8	Germany	107,000,000	82,210,000	130.15	2009[11]
9	Pakistan	95,918,729	166,613,500	58.60	Oct 2009[12]
10	Italy	88,580,000	60,090,400	147.41	Dec.2008[13]
11	Mexico	79,400,000	109,610,000	72.44	Mar.2009[14]
12	United Kingdom	75,750,000	61,612,300	122.95	Dec. 2008[15]
13	Vietnam	70,000,000	87,375,000	80.11	2009[16]
14	Philippines	67,900,000	92,226,600	73.62	Dec. 2008[17]
15	Turkey	66,000,000	71,517,100	92.29	2009[18]

Cell Phone Policy:

With approximately 1 Billion sold in 2009

At $100/phone, this is a $100 Billion Business

Infrastructure to support approximately 4 billion cell phones is much larger

Electronics Market in Perspective

Corn and Beans are Big Business in Iowa and in the United States

Electronics Market in Perspective

How much corn is produced in the US each year?

What is the value of all of the corn produced in the US ?

How many soybeans are produced in the US each year?

What is the value of all of the soybeans produced in the US ?

Electronics Market in Perspective

How much corn is produced in the US each year?

Approx 11 Billion Bushels

What is the value of all of the corn produced in the US ?

Approx $40 Billion

How many soybeans are produced in the US each year?

Approx 3.1 Billion Bushels

What is the value of all of the soybeans produced in the US ?

Approx $25 Billion

Electronics Market in Perspective

How big is the electronics market?

Semiconductor Industry Approx $260 Billion in 2010

Electronics Industry is Much Larger !!

Electronics Industry is one of the largest industries in the world and will continue to grow in importance for the foreseeable future

Electronics Market in Perspective

Consider one large electronics company

intel

Market Capitalization $115 Billion (Jan 8, 2010)

Annual Sales Approx $33 Billion in 2009

84,000 Employees

Electronics Market in Perspective

Annual sales of one electronics company comparable to half of the value of all corn and all beans produced in the entire US

Through much of the past 15 years, annual sales of Intel has been comparable to the value of all corn and all beans produced in the entire US

Electronics Market in Perspective

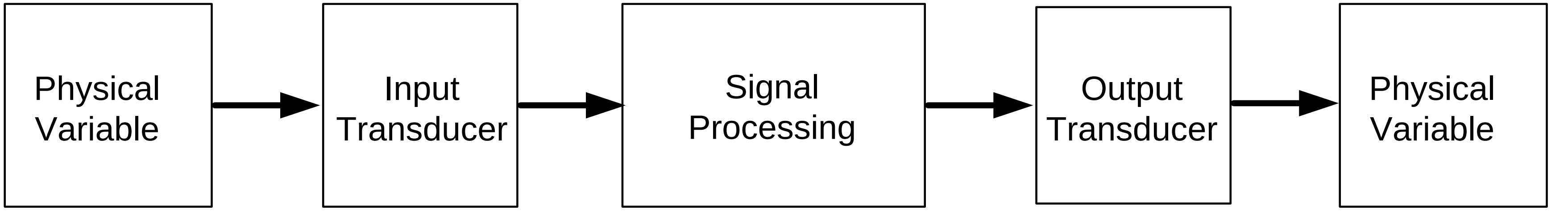
Use of electronic components and systems by consumers around the world is a major reason substantial career opportunities exist for electrical engineers !!

Cell Phone Policy:

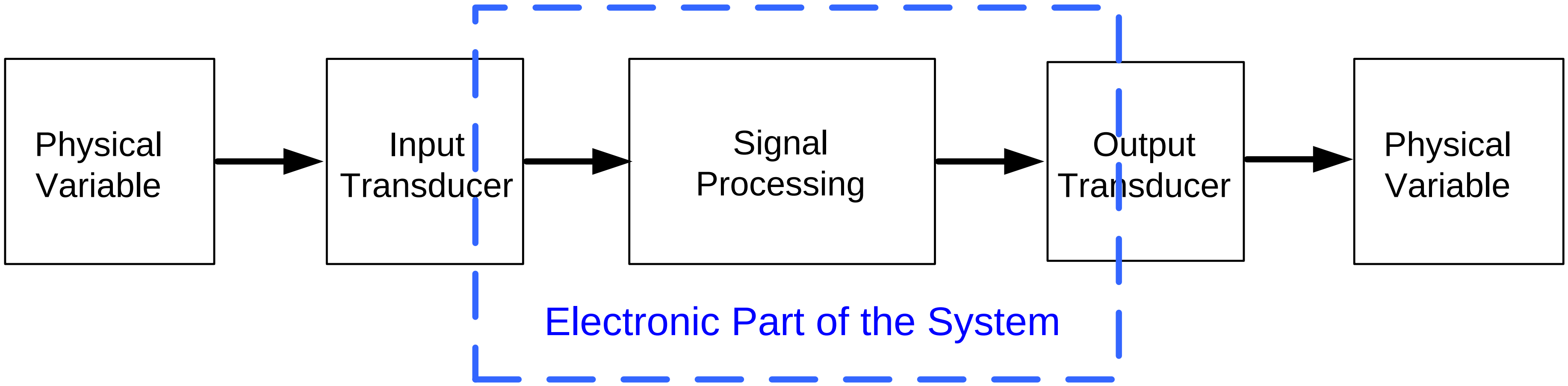
Cell phone use is one of many constant reminders of the importance of the electronic industry on opportunities for electrical engineers

Let them ring !!

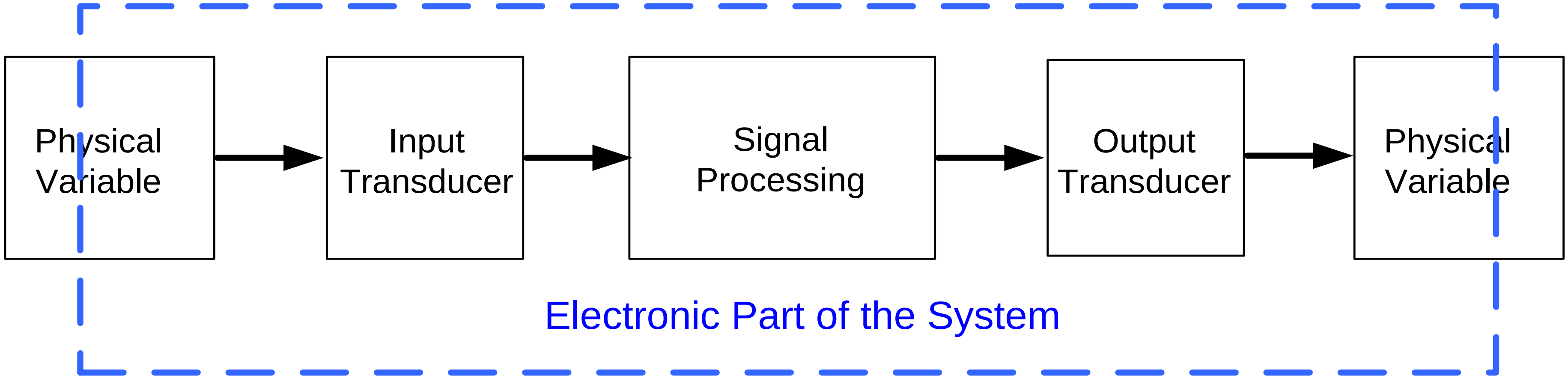
Typical Electronic System



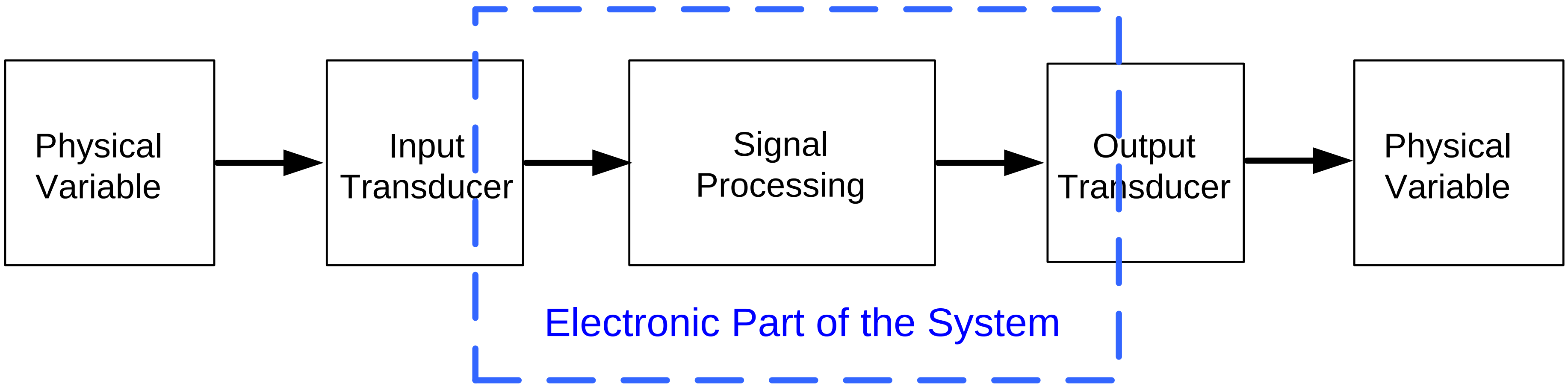
Typical Electronic System



And often even



Typical Electronic System

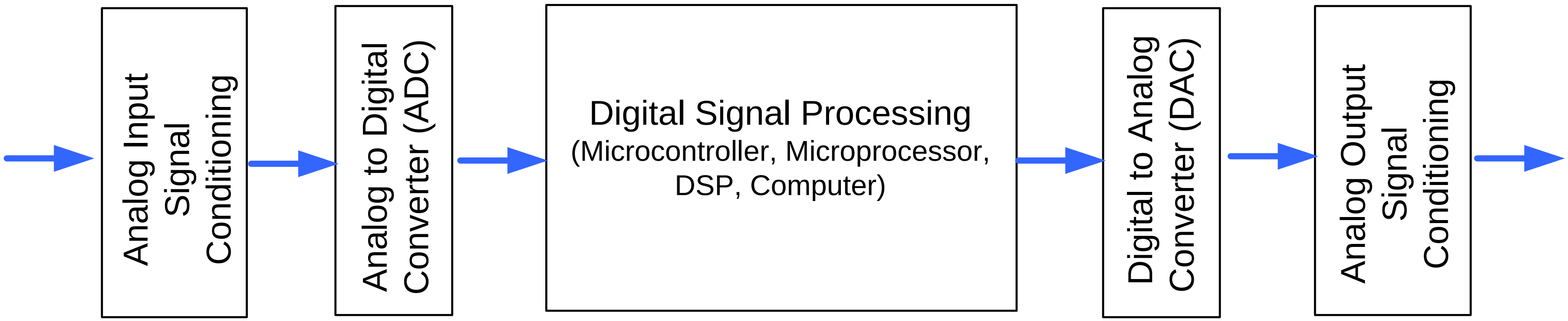


Electronic Part of the System

- Primarily Resistors, Capacitors, Inductors MOSFETS, BJTs Diodes
- As few as 1 or 2 components or as many as several billion
- Groups of Components often interconnected and re-used

  dependent sources, amplifiers, logic gates, ADCs and DACs, ALU, microprocessor, adders, PLLs, computer, …

Typical Electronic Part of the System



Integrated Circuits and some Passive Components Invariably Used in each of these 5 Blocks

Groups (often very large) of transistors used to build ICs but very limited use of individual transistors external to the integrated circuits

Engineers Role in Electronic System Design

- Connects groups of components or blocks together to design the system
- Primarily Two Types of Electronics Designers
  - Connects integrated circuits and some components together to form electronic system (Electronic System Designer)
  - Connects individual transistors and components together to form integrated circuits (IC designer)

Engineers Role in Electronic System Design

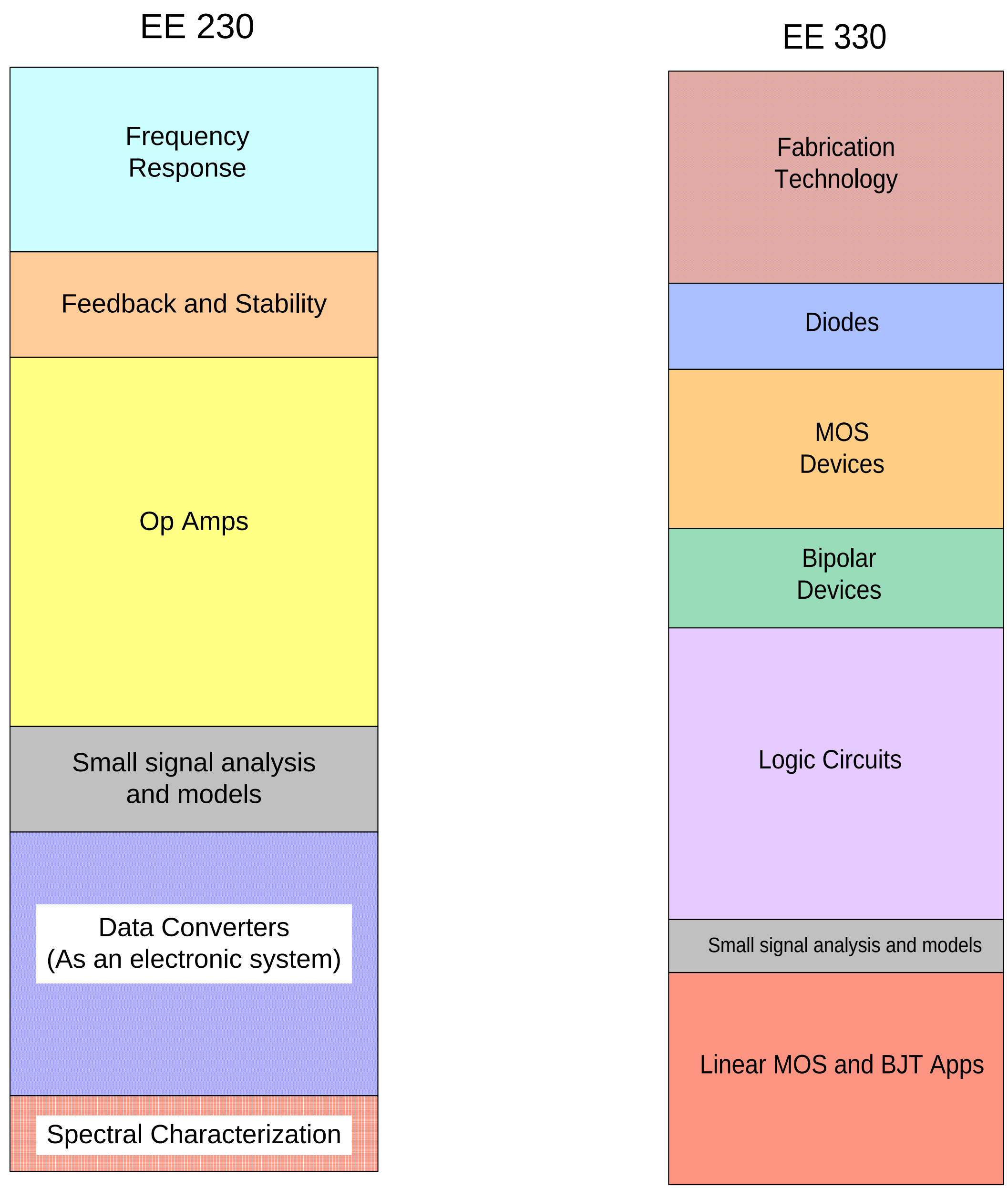
- Primarily Two Types of Electronics Designers
  - Connects integrated circuits and some components together to form electronic system (Electronic System Designer)

    EE 230

  - Connects individual transistors and components together to form integrated circuits (IC designer)

    EE 330

Material Partitioning in 07-09 Catalog



Course Objectives: EE230

- **Objective 1**: Determine the frequency response of linear electronic systems and relationship with sinusoidal steady state response
- **Objective 2**: Determine frequency selective properties of electronic circuits from their frequency domain response
- **Objective 3**: Determine stability of simple circuits and systems by analyzing their time domain response or by investigating characteristics of their frequency domain response
- Objective 4: Know concepts of feedback and implications of feedback on stability, sensitivity, and frequency response

Course Objectives: EE230

- **Objective 5**: Describe ideal and non-ideal characteristics of Op Amps and determine Op Amp specifications through simulation or measurement
- **Objective 6**: Design inverting and non-inverting amplifiers, buffers, filters, and other basic feedback circuits using Op Amps
- **Objective 7**: Perform small signal analysis of nonlinear circuits via local linearization at a given operating point and obtain linear models in time and frequency domains

Course Objectives: EE230

- **Objective 8**: Determine the ideal and non-ideal characteristics of analog-to-digital and digital-to-analog converters in both voltage and frequency domains
- **Objective 9**: Design simple analog-digital interface circuits using ADCs and DACs with suitable specifications to meet a given performance requirement
- **Objective 10**: Compute static and dynamic distortion of circuits and systems using spectral characterization