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
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

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: rjgeiger@iastate.edu
Office Hours: Maintains an open-door policy, will reserve 9:00 to 10:00 MWF specifically

Laboratory Instructors and Teaching Assistants:
Yassim Labyed labyed@iastate.edu
Gunjan Pandey gpan@iastate.edu
Lei Ke keleu@iastate.edu

Course Description:
3 (3-3) Cr. 4 F.S. Prereq: 201, Math 257, 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 distortion, 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

<table>
<thead>
<tr>
<th>Year</th>
<th>Units (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>107.84</td>
</tr>
<tr>
<td>1998</td>
<td>175.65</td>
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<tr>
<td>1999</td>
<td>295.15</td>
</tr>
<tr>
<td>2000</td>
<td>414.99</td>
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<td>413.31</td>
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<td>2002</td>
<td>427.37</td>
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<tr>
<td>2003</td>
<td>519.99</td>
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<tr>
<td>2004</td>
<td>674.00</td>
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<tr>
<td>2005</td>
<td>778.75</td>
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<tr>
<td>2006</td>
<td>847.24</td>
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<tr>
<td>2007</td>
<td>914.02</td>
</tr>
<tr>
<td>2008</td>
<td>980.29</td>
</tr>
<tr>
<td>2009</td>
<td>1,041.52</td>
</tr>
</tbody>
</table>

Source: Gartner Dataquest (July 2005)
### Top 15 countries using cell phones

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country or region</th>
<th>Number of mobile phones</th>
<th>Population</th>
<th>% of population</th>
<th>Last updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>720,000,000</td>
<td>1,324,190,000</td>
<td>54.00</td>
<td>Aug 2009[3]</td>
</tr>
<tr>
<td>2</td>
<td>India</td>
<td>506,044,156</td>
<td>1,172,756,000</td>
<td>43.15</td>
<td>Nov 2009[4]</td>
</tr>
<tr>
<td>4</td>
<td>Russia</td>
<td>190,000,000</td>
<td>141,812,991</td>
<td>134</td>
<td>Feb. 2009[8]</td>
</tr>
<tr>
<td>5</td>
<td>Brazil</td>
<td>169,800,000</td>
<td>189,985,135</td>
<td>89.37</td>
<td>Nov. 2009[7][8]</td>
</tr>
<tr>
<td>6</td>
<td>Indonesia</td>
<td>140,200,000</td>
<td>231,627,000</td>
<td>60.53</td>
<td>Dec. 2008[9]</td>
</tr>
<tr>
<td>7</td>
<td>Japan</td>
<td>107,490,000</td>
<td>127,790,000</td>
<td>84.11</td>
<td>Mar. 2009[10]</td>
</tr>
<tr>
<td>8</td>
<td>Germany</td>
<td>107,000,000</td>
<td>82,210,000</td>
<td>130.15</td>
<td>2009[11]</td>
</tr>
<tr>
<td>9</td>
<td>Pakistan</td>
<td>95,918,729</td>
<td>166,613,500</td>
<td>58.60</td>
<td>Oct 2009[12]</td>
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<tr>
<td>10</td>
<td>Italy</td>
<td>88,580,000</td>
<td>60,090,400</td>
<td>147.41</td>
<td>Dec.2008[13]</td>
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<tr>
<td>11</td>
<td>Mexico</td>
<td>79,400,000</td>
<td>109,610,000</td>
<td>72.44</td>
<td>Mar.2009[14]</td>
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<tr>
<td>12</td>
<td>United Kingdom</td>
<td>75,750,000</td>
<td>61,612,300</td>
<td>122.95</td>
<td>Dec. 2008[15]</td>
</tr>
<tr>
<td>13</td>
<td>Vietnam</td>
<td>70,000,000</td>
<td>87,375,000</td>
<td>80.11</td>
<td>2009[16]</td>
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<tr>
<td>14</td>
<td>Philippines</td>
<td>67,900,000</td>
<td>92,226,600</td>
<td>73.62</td>
<td>Dec. 2006[17]</td>
</tr>
<tr>
<td>15</td>
<td>Turkey</td>
<td>66,000,000</td>
<td>71,517,100</td>
<td>92.29</td>
<td>2009[18]</td>
</tr>
</tbody>
</table>
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

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 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

Physical Variable → Input Transducer → Signal Processing → Output Transducer → Physical Variable
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
EE 230

- Frequency Response
- Feedback and Stability
- Op Amps
- Small signal analysis and models
- Data Converters
  (As an electronic system)
- Spectral Characterization

EE 330

- Fabrication Technology
- Diodes
- MOS Devices
- Bipolar Devices
- Logic Circuits
- Small signal analysis and models
- Linear MOS and BJT Apps

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