Agenda

Course Objectives

Course Information

Lectures List

Basic Concepts
Course Objectives

• **Understand the transistor biasing, modeling, and its small-signal analysis.**

• **Analyze the transistor circuits at low, medium and high frequencies and study its frequency response using bode plots.**

• **Explain the operation of tuned amplifiers and power amplifiers.**

• **Learn the difference between amplifiers and oscillators and study the oscillator circuits.**

• **Study the mixers and modulators circuits.**
## Course Information

| Instructor: | Dr. Ahmad El-Banna  
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<td></td>
<td><a href="https://www.linkedin.com/pub/ahmad-el-banna/32/6a3/495">https://www.linkedin.com/pub/ahmad-el-banna/32/6a3/495</a></td>
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</tbody>
</table>
|             | Office: Room #306  
|             | Email: ahmad.elbanna@feng.bu.edu.eg  
|             | ahmad.elbanna@ejust.edu.eg |

| Lectures: | Tuesday: 14:00-15:30  
|           | Wednesday: 12:30-14:00  
|           | Prerequisite: ECE-121 & ECE-222 |

| Office Hours: | Sunday(10:30~11:30), Tuesday(14:00~16:30) & Wednesday (14:00~16:30) |

| T.A.: | Eng. Heba Adly |

| Texts/Notes: | Lectures slides, available by each lecture, and found online at [https://speakerdeck.com/ahmad_elbanna](https://speakerdeck.com/ahmad_elbanna)  
## Course Information

### Additional References:
- EE113 Course Notes Electronic Circuits by Prof. G. Kovacs, Stanford University, Department of Electrical Engineering.

### Credit:
- 150 Marks

### Grading:
- **60%**
  - Final Exam (Closed-Book)
- **20%**
  - Mid Term Exam (Open-Book) (10%)
  - Homework and tutorials activities (10%)
- **20%**
  - Individual Project and Quizzes (10%)
  - Group Project and Quizzes (10%)
Lectures List

**Week#1**
- Lec#1: Introduction and Basic Concepts

**Week#2**
- Lec#2: BJT Review
- Lec#3: BJT Biasing Circuits

**Week#3**
- Lec#4: BJT Modeling and $r_e$ Transistor Model
- Lec#5: Hybrid Equivalent Model

**Week#4**
- Lec#6: BJT Small-Signal Analysis
- Lec#7: Systems Approach

**Week#5**
- Lec#8: General Frequency Considerations
- Lec#9: BJT Low Frequency Response

**Week#6**
- Lec#10: BJT High Frequency Response
- Lec#11: Multistage Frequency Effects and Square-Wave Testing
Lectures List..

Week#7
- Lec#12: Power Amplifiers (Class A & B)
- Lec#13: Power Amplifiers (Class C & D)

Week#8
- Lec#14: Tuned Amplifiers (p1)
- Lec#15: Tuned Amplifiers (p2)

Week#9
- Lec#16: Oscillators (RC Circuits)
- Lec#17: Oscillators (LC Circuits)

Week#10
- Lec#18: Mixers Circuits (p1)
- Lec#19: Mixers Circuits (p2)

Week#11
- Lec#20: Modulation Circuits (p1)
- Lec#21: Modulation Circuits (p2)

Week#12
- Lec#22: Project Delivery and Oral Exam (Group1)
- Lec#23: Project Delivery and Oral Exam (Group2)
Review

BASIC CONCEPTS
Sources

- **AC/DC:**

- **Voltage/Current, Practical/Ideal:**

- **Equivalent:** Thévenin & Norton
  \[ I_{SC} = \frac{V_{OC}}{R_0} \]
Signals

- Amplitude!
- Frequency!
- Peak Voltage!
- RMS value!

To compute the RMS, take the signal, square it, average it, and take the square root...

\[ V_{\text{RMS}} = \sqrt{\text{AVG}(v(t))^2} = \sqrt{\frac{1}{T} \int_0^T v(t)^2 \, dt} \]

Some useful RMS formulas:

- Sinewave RMS: \[ \frac{V_{\text{peak}}}{\sqrt{2}} = \frac{V_{\text{peak-to-peak}}}{2\sqrt{2}} \]
- Symmetrical Squarewave RMS: \[ V_{\text{peak}} = \frac{V_{\text{peak-to-peak}}}{2} \]
- Triangle Wave RMS: \[ \frac{V_{\text{peak}}}{\sqrt{3}} = \frac{V_{\text{peak-to-peak}}}{2\sqrt{3}} \]
Amplifiers

- Gain!
- Input Resistance/Impedance!
- Output Resistance/Impedance!

VOLTAGE GAIN = $A_v = \frac{v_o}{v_i}$

POWER gain

$\text{dB} = 10 \log_{10}\left(\frac{P_{out}}{P_{in}}\right) \text{dB} = 20 \log_{10}(A_v)$

POWER GAIN = $A_p = \frac{P_o}{P_i} = \frac{i_0v_o}{i_i v_i}$
## Amplifiers Characteristics

<table>
<thead>
<tr>
<th>Source Parameter to be Amplified</th>
<th>Desired Output Parameter</th>
<th>Type of Amplifier</th>
<th>Gain Expression</th>
<th>Ideal Input Impedance</th>
<th>Ideal Output Impedance</th>
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</thead>
<tbody>
<tr>
<td>source voltage, $v_s$</td>
<td>$v_o$</td>
<td>Voltage</td>
<td>$A_V = \frac{v_o}{v_s} =$ voltage gain (dimensionless)</td>
<td>$Z_i = \infty$</td>
<td>$Z_o = 0$</td>
</tr>
<tr>
<td>source voltage, $v_s$</td>
<td>$i_o$</td>
<td>Transconductance</td>
<td>$G_m = \frac{i_o}{v_s} =$ transconductance in $\Omega^{-1}$ or Siemens</td>
<td>$Z_i = \infty$</td>
<td>$Z_o = \infty$</td>
</tr>
<tr>
<td>source current, $i_s$</td>
<td>$v_o$</td>
<td>Transresistance</td>
<td>$R_m = \frac{v_o}{i_s} =$ transresistance in $\Omega$</td>
<td>$Z_i = 0$</td>
<td>$Z_o = 0$</td>
</tr>
<tr>
<td>source current, $i_s$</td>
<td>$i_o$</td>
<td>Current</td>
<td>$A_I = \frac{i_o}{i_s} =$ current gain (dimensionless)</td>
<td>$Z_i = 0$</td>
<td>$Z_o = \infty$</td>
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Noise & Distortion

**NOISE** is unwanted signal(s) that end up added to the desired signals.

- **DISTORTION** of a signal occurs when the amplified version of the signal coming out of the amplifier is not simply a scaled copy of the input signal, but is differently shaped (distorted).

![Crossover Distortion](image)

Amplifier clipping - +Vc and -Vc are power supply voltages.
Amplifier Power Supply and Efficiency

- All amplifiers need some type of power supply to supply the extra energy that is delivered to the load.

- Most analog amplifiers use two power supply voltages or “rails,” as shown below,

\[ V_+ \]
\[ V_- \]
\[ I_{dc} \]
\[ i_i \]
\[ V_i \]
\[ R_L \]
\[ i_o \]

- Some amplifiers use only a single power supply voltage, but sometimes they internally "split" that single voltage into two rails by making an artificial "ground" voltage half way from "real ground" to the supply voltage.

- The efficiency of an amplifier reflects the amount of power delivered to the load as a fraction of the total power drawn from the power supply, and can be computed using:

\[ \eta = \frac{P_L}{P_{dc}} \times 100\% = \frac{\text{Power Delivered to Load}}{\text{Power Used from Power Supplies}} \times 100\% \]
Diodes

Ideal semiconductor diode: (a) forward-biased; (b) reverse-biased.

Various types of junction diodes.

- General purpose diode
- Surface mount high-power PIN diode
- Power (stud) diode
- Power (planar) diode
- Beam lead pin diode
- Flat chip surface mount diode
- Power diode
- Power (disc, pack) diode

**DIODE TESTING**

Diode Checking Function

Ohmmeter Testing

Red lead (VΩ) | Black lead (COM)
---|---
Red lead (VΩ) | Black lead (COM)

Relatively low $R$

Relatively high $R$

(a)

(b)
• For more details, refer to:
  • Text books for ECE-121, ECE-222.
• The lecture is available online at:
  • https://speakerdeck.com/ahmad_elbanna
• For inquires, send to:
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