820243 - ECEIA - Communication Electronics

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2015
Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: HERMINIO MARTINEZ GARCIA.
Others: HERMINIO MARTINEZ GARCIA i d'altres a determinar.

Opening hours
Timetable: To determine at the semester beginning. It will be announced to the whole students the first week of the course.

Degree competences to which the subject contributes

Specific:
1. Summarise information and undertake self-directed learning activities.
2. Identify, understand and apply the principles of information and communication systems to healthcare.
3. Design analogue, digital and power systems.
4. Apply their knowledge to industrial informatics and communications.
5. Understand the fundamentals and applications of analogue electronics.
6. Understand the fundamentals and applications of digital electronics and microprocessors.

Transversal:
7. EFFECTIVE USE OF INFORMATION RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.

Teaching methodology
Please, see Spanish or Catalan version.

Learning objectives of the subject
Please, see Spanish or Catalan version.
### Study load

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong></td>
<td>150h</td>
<td></td>
</tr>
<tr>
<td>Hours large group:</td>
<td>45h</td>
<td>30.00%</td>
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<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</tbody>
</table>
## Content

### 1.- Introduction to the Electronic Communications with Modulation Techniques.

**Description:**
- 1.2. - Historical development of electronic communications.
- 1.3. - Physical transmission media. General characteristics and electrical model of a transmission line.
  - 1.3.1. - Twisted pair.
  - 1.3.2. - Coaxial cable.
  - 1.3.3. - Optic Fiber (OF).
  - 1.3.4. - Wireless.
  - 1.3.4.1. - Microwave.
  - 1.3.4.2. - Infrared.
- 1.4. - Types of transmission.
  - 1.4.1. - Direct digital baseband transmission.
  - 1.4.2. - Carrier modulation transmission. Broadband transmission.
  - 1.4.2.1. - Introduction to the modulation process in modem communications.
- 1.5. - Definition of 'modulation'.
- 1.6. - Spectrum of electromagnetic waves.
- 1.7. - Complex periodic signals: Review of the analysis and Fourier series.
  - 1.7.1. - Fourier theorem.
- 1.8. - Type of modulation.
- 1.9. - Electrical noise.
  - 1.9.1. - Types and sources of electrical noise.
  - 1.9.2. - SNR or signal-to-noise ratio.

### Learning time:
- 7h 30m
- Theory classes: 3h
- Self study: 4h 30m
# 2.- Linear Modulation: Amplitude Modulation (A.M.).

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 18h 15m</th>
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</thead>
<tbody>
<tr>
<td>2.1.- Definition of 'amplitude modulation'.</td>
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<tr>
<td>2.2.- Mathematical study of AM modulation process.</td>
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<tr>
<td>2.3.- Types of amplitude modulations.</td>
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<tr>
<td>2.3.1.- Frequency spectrum of DSBLC (double side band with large carrier) modulation.</td>
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<tr>
<td>2.3.2.- Advantages of carrier suppression: DSBSC (double side band with suppressed carrier) modulation.</td>
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<tr>
<td>2.3.3.- Advantages and disadvantages of systems with SSB (single side band) modulation.</td>
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<tr>
<td>2.3.4.- Vestigial band modulation.</td>
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<tr>
<td>2.4.- Reminder of the Fourier transform.</td>
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<tr>
<td>2.4.1.- Frequency translation theorem.</td>
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<tr>
<td>2.4.2.- Modulation theorem.</td>
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<tr>
<td>2.5.- Energy density spectra: theorems of Parseval and Plancharel.</td>
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</table>
### 3.- Electronic Circuits and Systems for Transmitting and Receiving Equipments with AM Modulation.

**Learning time:** 20h 15m  
Theory classes: 6h  
Laboratory classes: 3h  
Self study: 11h 15m

<table>
<thead>
<tr>
<th>Description</th>
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</thead>
</table>
| 3.1.- Introduction to electronic circuits and systems for equipment with modulation AM transmitters and receivers.  
3.2.- AM modulator circuits.  
3.2.1.- AM modulators with suppressed carrier.  
3.2.2.- DSB modulators.  
3.2.3.- SSB modulators.  
3.3.- AM demodulator circuits.  
3.3.1.- Synchronous (or coherent) demodulation/detection.  
3.3.2.- Envelope detector with diode and transistor or RC network (asynchronous demodulation).  
3.4.- Radio receiver circuits.  
3.4.1.- Historical overview to radio receivers.  
3.4.2.- Technical design of old receivers.  
3.4.2.1.- Homodin receivers or tuned radio-frequency (TRF) receivers.  
3.4.2.2.- Regenerative receivers.  
3.4.2.3.- Super-regenerative receivers.  
3.4.2.4.- Reflex receivers.  
3.4.2.5.- Autodin receivers.  
3.4.2.6.- Heterodyne receivers.  
3.4.3.- Technical design of modern radio receivers.  
3.4.3.1.- Superheterodine receivers.  
3.4.3.2.- Dual conversion superheterodine receivers.  
3.4.4.- Features and parameters of receivers: sensitivity, selectivity, distortion, dynamic range, fidelity, insertion loss, noise temperature, noise equivalent temperature, etc..  
3.4.5.- Complete structure of AM radio receivers. |
### 4.- Angular or Exponential Modulation: Frequency Modulation (FM) and Phase Modulation (PM).

**Learning time:** 16h  
Theory classes: 5h  
Laboratory classes: 2h  
Self study: 9h

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>4.1. - Definition of 'angular modulation'.</td>
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<tr>
<td>4.2. - Types of angular modulations.</td>
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<tr>
<td>4.2.1. - Frequency Modulation (FM).</td>
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<tr>
<td>4.2.1.1. - Narrowband FM.</td>
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<tr>
<td>4.2.1.2. - Bandwidth FM.</td>
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<tr>
<td>4.2.2. - Phase Modulation (PM).</td>
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<tr>
<td>4.3. - Mathematical Study of FM modulation process.</td>
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<tr>
<td>4.3.1. - FM frequency spectrum.</td>
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<td>4.3.2. - Modulation with a sinusoidal modulating signal.</td>
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<tr>
<td>4.3.2.1. - Total power transmitted and power distribution between the different components of the FM spectrum.</td>
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<tr>
<td>4.3.3. - Modulation with a rectangular modulating signal.</td>
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<tr>
<td>4.3.4. - Bandwidth estimation for an FM signal in the case of a general modulating waveform. Carson rule.</td>
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</table>
5.- Electronic Circuits and Systems for Transmitting and Receiving Equipments with FM modulation.

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>17h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>6h</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>2h</td>
</tr>
<tr>
<td>Self study:</td>
<td>9h</td>
</tr>
</tbody>
</table>

Description:

5.1.- Introduction to the electronic circuits and systems for transmitters and receiving equipments with FM modulation.

5.2.- The varicap (or varactor) diode.

5.2.1.- Operation and characteristics.
5.2.2.- Application circuits in Electronics and Communications.

5.3.- FM modulator circuits.

5.3.1.- The VCO as basic FM modulator block.
5.3.2.- Application circuits of the varactor diode in FM modulators.

5.4. - PLL (or phase-locked loop) circuits.

5.4.1. - Introduction to PLL circuits.
5.4.2. - Overview, and classification block diagram of PLL circuits.
5.4.3. - Principle of operation of a PLL circuit.
5.4.4. - Transfer curve and definition of parameters.
5.4.5. - Operation at the acquisition phase.
5.4.6. - Modelling of a basic linear PLL circuit.
5.4.7.- Applications of PLL circuits. Study of electronic PLL circuits.

5.4.7.1.- Multipliers, dividers and frequency synthesizers.
5.4.7.2.- Tone Detector and signal filtering in noisy environment.
5.4.7.3.- Applications in electronic communications. Signal modulation and demodulation.

5.4.8.- Typical commercial PLLs in the form of integrated circuits.

5.4.8.1.- The integrated circuit LM565 and HEF4046 as examples.

5.4.9.- Limitations of PLL circuits.

5.5.- FM demodulator circuits.

5.5.1.- Slope detector or discriminator.
5.5.2.- Balanced slope detector.
5.5.3.- Foster-Seeley discriminator.
5.5.4.- Demodulation of FM signals based on PLL circuitry.

5.6.- Mono-stereo FM multiplex system (FM stereo).
5.7.- Complete structure of FM radio receivers.
### 6.- Pulse Modulations and Digital Communications

**Description:**
- 6.1.- Definition of 'pulse modulation'.
- 6.2.- Types of pulse modulations.
  - 6.2.1.- Pulse-amplitude modulation (PAM).
  - 6.2.2.- Pulse-width modulation (PWM).
  - 6.2.3.- Pulse-duration modulation (PDM).
  - 6.2.4.- Pulse-code modulation (PCM).
- 6.3.- PAM modulator circuit.
- 6.4.- Spectrum of a PAM modulated signal.
- 6.5.- Detection of PAM signals.
- 6.6.- PWM modulation and demodulation.
- 6.7.- PCM modulation and demodulation.
- 6.8.- Delta PCM modulation.
- 6.9.- Adaptive Delta PCM modulation.

**Learning time:** 16h
- Theory classes: 5h
- Laboratory classes: 2h
- Self study: 9h

### 7.- Introduction to Propagation of Radio Waves

**Description:**
- 7.1.- Introduction.
- 7.2.- Electromagnetic waves and electromagnetic radiation.
- 7.3.- Propagation of radio waves in free space
- 7.4.- Attenuation and losses of radio waves.
- 7.5.- Optical and radio horizons.
- 7.6.- The behavior of radio waves: reflection, refraction, diffraction and scattering of radio waves.
- 7.7.- Modes of propagation of radio waves.
  - 7.7.1.- GW (or 'ground wave') propagation.
  - 7.7.2.- SW (or 'sky wave') propagation.
  - 7.7.3.- LOS (or 'line-of-sight') propagation.
- 7.8.- Propagation in a mobile and portable environment.
- 7.9.- Repeaters and cellular systems.
- 7.10.- Other modes of propagation.
- 7.11.- Fading of radio signals.

**Learning time:** 12h
- Theory classes: 3h
- Self study: 9h
8.- Introduction to the Transmitting and Receiving Antennas

**Description:**
8.1.- Introduction.
8.2.- Simple antenna.
8.3.- Characteristics of antennas: polarization and radiation pattern of an antenna, characteristic impedance and resistance of an antenna.
8.4.- Other simple antennas.
8.4.1.- Half-wave dipole.
8.4.2.- Grounded antenna.
8.5.- Antenna components and reflective elements. The Yagi-Uda arrangement.
8.6.- Antenna load.
8.7.- Antennas for UHF, microwave and mobile telephony.
8.8.- Guided waves.

Learning time: 12h
- Theory classes: 3h
- Self study: 9h

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9.- Applications of Modulation Techniques to Electronic Communication Systems.

**Description:**
9.1.- Multiplexing techniques.
9.1.1.- Frequency-division multiplexing (FDM).
9.1.2.- Time-division multiplexing (TDM).
9.1.3.- Frequency hopping multiplexing.
9.1.4.- Code division multiplexing (CDM).
9.2.- Applications of the single sideband (SSB) systems.
9.2.1.- Simultaneous transmission of signals through a coaxial cable with FDM.
9.2.2.- Transmission of high frequency signals through power lines.
9.3.- Channels for different radio and TV services.
9.4.- FM Communications industry. Bands assigned to other communication services.
9.5.- Introduction to analog TV and analog image processing.
9.6.- Introduction to mobile telephony.

Learning time: 15h 30m
- Theory classes: 4h 30m
- Laboratory classes: 2h
- Self study: 9h
10.- Digital Modulations and Communication MODEMs.

**Description:**
10.2. - Classification of communication modems.
10.3. - Data compression.
10.4. - Operation and basic modulations of low-speed modems.
10.4.1. - ASK ('amplitude shift keying') and OOK ('on-off keying') modulations.
10.4.2. - FSK ('frequency shift keying') modulation.
10.4.3. - PSK ('phase shift keying') modulation.
10.5. - Main types of digital modulation used in high-speed modems.
10.5.1. - Quadrature PSK (QPSK) modulation.
10.5.2. - M-state PSK (M-PSK) modulation.
10.5.3. - M-state amplitude and phase shift keying (M-APK) modulation.
10.6. - Asynchronous and synchronous modems.
10.6.1. - Type of asynchronous modems.
10.6.2. - Synchronous modems. V.xx recommendations.
10.7. - Standard computer-modem connection.
10.8. - MNP ('microcomputer networking protocol') protocols.

**Learning time:** 15h 30m
Theory classes: 4h 30m
Laboratory classes: 2h
Self study: 9h

Qualification system
Please, see Spanish or Catalan version.

Regulations for carrying out activities
Please, see Spanish or Catalan version.
Bibliography

Basic:


Complementary:


Others resources:

Hyperlink

Moodle ATENEA: http://atenea.upc.edu/moodle/