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| | **BSc in SYSTEMS ENGINEERING** | | |
| | **COURSE: Fonaments físics de la Informàtica (Basic concepts of physics applied to Computer Science)** | | |
| | **TEACHING STAFF: Miquel Carrera** | | |
| | **COURSE: 05-06** | **CREDITS: 7.5** | **TYPE: Compulsory** |

## 1. OBJECTIVES

This course aims to introduce the principles and the basic laws of physics which will allow future computer scientists to understand better the technology they use. For this reason, the program focuses on electricity, magnetism and electromagnetic waves with particular emphasis on the basic techniques for the analysis of electrical circuits. For computer scientists this course establishes a link with other courses like Electrònica (Electronics) and Teoria de circuits (Circuits Theory). In general, this course is useful for those computer systems which involve a control mechanism that adds sensors, transducers and other similar devices.

## 2. STRUCTURE

Four-monthly: 7.5 credits
Theoretical credits: 3.5
Practical credits: 4

## 3. PROGRAM

**I. Electricity and magnetism**

**1. Electrical field.**
- Electrical load. Coulomb's law.
- Electrical field.
- Electrical field calculation through Coulomb's Law.
- Electrical field flow. Gauss' Law.
- Electrical field calculation through Gauss 'Law.
- Particle movement charged in a uniform field. Oscilloscope.
- Conductors in an electrostatic equilibrium. Load and field.

**2. Electrical Potential.**
- Electrostatic potential energy and electrical potential.
- Potential in a system of punctual charges.
- Potential in continuous charge distributions.
- General relation between electrical field and potential.
- Equipotential surface.

**3. Condensers. Dielectrics.**
- Condensers. Capacity.
- Electric energy stored in a condenser.
- Energy density in an electrostatic field.
- Dielectrics. Polarization.
- Condensers with dielectrics

**4. Electrokinetics.**

- Electrical current. Current density.
- Ohm's Law. Electric resistance.
- Resistivity.
- Electrical conduction in conductors and semiconductors.

**5. Magnetic field.**

- Magnetic field definition and properties.
- Magnetic force over a mobile charge.
- Magnetic force over a current element and a conductor.
- Magnets inside a magnetic field. Magnetic momentum.
- Magnetic field action over a spiral.
- Charges movement inside a magnetic field. Applications.
- Hall effect. Sensors of a magnetic field.

**6. Magnetic field sources.**

- Magnetic field created by punctual mobile charges.
- Biot and Savart's Law. Field created by a current.
- Magnetic field calculus using Biot-Savart Law.
- Magnetic forces between parallel currents.
- Ampere's Law. Application to magnetic field calculus.
- Magnetic flow.

**7. Magnetic induction.**

- Magnetic induction phenomena.
- Faraday-Lenz Law. Induced electromotive force.
- Electromotive force of movement.
- Foucault currents.
- Generators and engines. Operation principles.
- Mutual induction and auto induction.
- Magnetic energy.

**II. Circuits fundamentals.**

**1. Basic concepts.**

- Basic magnitudes. Units.
- Energy and power.
- Sign criteria.
- Elements of a circuit:
  - Active elements and passive elements
  - Independent sources and dependent sources
- Condensers and coils.

**2. Resistive circuits.**

- Resistance. Ohm's Law.
- Kirchhoff Laws.
- One network circuits.
  - Voltage dividers.
  - Voltage Source arrangements
  - Resistance arrangements
- Circuit with one pair of nodes
  - Current divisor.
  - Current source arrangements
  - Resistance arrangements
- Circuits with dependent sources
- Voltage and current measurements. Equipment
- Resistance measurements. Wheatstone bridge.
- Star-triangle transformation

**3. Circuit Analysis techniques.**

- Node voltage method.
  - Circuits that only have independent current sources.
  - Circuits that have dependent current sources.

Circuits that have independent voltage sources
Circuits that have dependent voltage sources.
- Network current method.
Circuits that only have independent voltage sources.
Circuits that have independent current sources.
Circuits that have dependent sources.
- Linearity and superimposition theorems.
- Source changes
Ideal sources and real sources
Equivalence between voltage sources and real current sources.
- Thèvenin and Norton theorems.
General Method
Alternative method for circuits with only dependent sources.
- Maximum transference of power.

**4. Transitory analysis (first and second order circuits)**
- RC circuit
- RL circuit
- LC circuit
- RLC circuit without generator (qualitative analysis of the behaviour)

**5. Sinusoid Alternating current.**
- R, L and C behaviour in alternating current.
- RLC with generator: equation, stationary current, phases diagram.
- Power in an A. C. circuit.
Effective value of an alternating magnitude
Power and power factor
- Complex impedance. Generalized Ohm's Law
- Series and parallel circuits. Admittance.
- Active and reactive power. Power triangle
- Resonance phenomena. Quality factor.

**III. Waves**

**1. Harmonic Undulatory movement**
- Pulse wave. Sorts of waves. Wave equations.
- Harmonic wave function
- Wave equations.
- Waves propagation speed.
- Harmonic wave energy and intensity.
- Harmonic wave superposition. Stationary waves.
- Range difference and wave phase shift.
- Periodic waves analysis.

**2. Electromagnetic waves.**
- Maxwell equations.
- Electromagnetic waves equation.
- Electromagnetic wave function. Poynting Vector.
- Electromagnetic waves energy.
- Electromagnetical spectrum.

**3. Light propagation.**
- Huygens principle.
- Reflection.
- Refraction.
- Total intern reflection. Optical fiber.
- Diffusion.
- Absorption.
- Polarization.

- Interference and diffraction.
- Phase difference and coherence.
- Double slit interference diagram.
- Coherent light: laser.

## 4. COURSE MATERIALS AND PROGRAM

A collection of problems.
A practical guide for the lab.

## 5. REFERENCES


Electromagnetism and waves (Part I and III):

**(*)**TIPLER, P.A. *Física.* Vol.II. Traducció al català de la 3a edició original. Ed. Reverté, 1994.

**(*)**TIPLER, P.A. *Física.* Vol.II. Traducció al castellà de la 4a edició original. Ed. Reverté, 1999.

SERWAY, R.A. *Electricidad y Magnetismo*. 4ª edición. Mc.Graw-Hill, 1999.

SEARS, F.W., ZEMANSKY, M.W., YOUNG, H.D., FREEDMAN, R.A. *Física* Vol. 2. Novena edición. Addison-Wesley Longman, 1999.

GETTYS, W.E., KELLER, F.S., SKOVE, M.J. *Física Clàsica y Moderna*. Mc. Graw-Hill, 1991.

ALONSO, M., FINN, E.J. *Física*. Addison-Wesley Iberoamericana, 1995.

LEA, S.M., BURKE, J.R. *Física 2, la naturaleza de las cosas*. Paraninfo, 2001.

GARCIA, N., DAMASK, A.C. *Physics for computer science students*. Springer-Verlag, 1991.

Basic circuits (part II):

**(*)**IRWIN, J. D. *Análisis básico de circuitos en Ingeniería*. Prentice-Hall, 1997. (5ª ed.)

JOHNSON, D.E., HILBURN, J.L., JOHNSON, J.R., SCOTT, P.D. *Análisis básico de circuitos eléctricos*. Prentice-Hall, 1996. (5ª ed.)

NILSSON, J.W. *Circuitos eléctricos*. Addisson-Wesley Publishing Company, 1995.

EDMINISTER, J.A. *Circuitos Eléctricos*. Mc.Graw-Hill, 1997.

Problems books:

GONZÁLEZ, F.A. *La Física en Problemas*. Ed. Tébar, 2000

RAMOS, A., RIVAS, J.M., JIMÉNEZ, M.A. *Ejercicios de Electricidad.* Ed.Tébar Flores. Madrid.

BUECHE, F.J., *Física General* (9ª ed.). Mc Graw-Hill, 2001.

GARCIA, J. *Problemas de Física*. Ed. Eunibar.

MARTÍNEZ, M., GONZÁLEZ, F.A. *Problemas de Física General*. Ed. Tébar Flores, Madrid, 1978.

BURBANO DE ERCILLA, S., BURBANO GARCÍA, E., GRACIA MUÑOZ, C. *Problemas de Física General* (26ª ed.). Mira Editores, Zaragoza, 1994.

(*) Specially recommended

## 5. ASSESSMENT

The assessment will be obtained from the results of the two parts that constitute this course:

- The students' knowledge will be assessed by means of an exam. It will amount to 80% of the final mark. This exam consists in the resolution of problems and course-related questions. There will be a final exam and a partial exam within the partial exam period established by the EPS. Active participation in class and in the tutorials about the resolution and discussion of problems will be taken into account, and it could suppose an increase of the final mark up to 1 point.

- Laboratory practical is a compulsory exercise. It contributes by 20% towards the final mark. The practical will be evaluated through a practical test in the laboratory and the submission of some reports.