Universidad Carlos III de Madrid

| COURSE: ELECTROMAGNETIC FIELDS | | |
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| DEGREE: Bachelor in Communication System Engineering | YEAR: 2nd. | SEMESTER: 2nd. |

**CRONOGRAMA ASIGNATURA**

| WEEK | SESSION | DESCRIPTION OF THE SESSION | GROUP (Put X) | | Indicate if space different from classroom (computer room, laboratory, etc..) | Indicate YES/NO If it is a session with two teachers (*) | Student work | | |
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| | | | Lecture | Small group | | | Description | Class hours | Student Workload per week (Max 7hours) |
| 1 | 1 | **Unit 1: The electromagnetic model**<br>• Presentation of the course contents<br>• Revision of Electrostatic and Magnetostatic. Introduction to Electrodynamics. | X | | NO | NO | Revision of electricity and magnetism | 1,66 | 4 |
| 1 | 2 | **Unit 1: The electromagnetic model**<br>• Maxwell equations. Displacement current. Boundary conditions. | | X | NO | NO | Studying basis of electrodynamics | 1,66 | |
| 2 | 3 | **Unit 1: The electromagnetic model**<br>• Boundary conditions for perfect conductor and perfect dielectric.<br>• Phasors. Maxwell equations in frequency domain. Complex permittivity. | X | | NO | NO | Revision of the theory seen in the lectures and resolution of exercises from course notes | 1,66 | 5 |
| 2 | 4 | **Unit 1: The electromagnetic model**<br>• Energy balance of Maxwell equations. Poynting theorem.<br>• Exercises | | X | NO | NO | Learning the Poynting theorem and its important consequences | 1,66 | |
| 3 | 5 | **Unit 2: Electromagnetic Propagation in a free medium: plane waves**<br>• Wave equation in an homogeneous free loss medium.<br>• Introduction to plane waves.<br>• Plane waves in lossy media. Good conductor. Good dielectric | X | | NO | NO | Learning the theory seen in the lectures. Solving small exercises about phasors and propagation constant | 1,66 | 5 |
| 3 | 6 | **Unit 2: Electromagnetic Propagation in a free médium: plane waves**<br>• Dispersion<br>• Polarization of a plane wave<br>• Exercises | | X | NO | NO | Studying the theory seen in the lectures. Solving small exercises about polarization | 1,66 | |

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| 4 | 7 | **Unit 2: Electromagnetic Propagation in a free medium: plane waves**<br>• Normal incidence<br>• Particular cases: lossless media, lossy media and perfect electric conductor<br>• Normal incidence in multiple media.<br>• | X | | NO | NO | Learning the theory seen in the lectures. Solving small exercises about normal incidence | 1,66 | 6 |
| 4 | 8 | **Lab 1.** Polarization of plane waves. | | X | Computers room from the UCIIIM | YES | To read and to prepare the Laboratory session. Reviewing basic MATLAB. The student will develop a code to study and understand plane wave polarization. | 1,66 | |
| 5 | 9 | **Unit 2: Electromagnetic Propagation in a free medium: plane waves**<br>• Oblique incidence: Snell law. Fresnel equations.<br>• Particular cases: Brewster and Critical angles | X | | NO | NO | Studying oblique incidence cases | 1,66 | 6 |
| 5 | 10 | **Unit 2: Electromagnetic Propagation in a free medium: plane waves**<br>• Resolution of problems | | X | NO | NO | Resolution of proposed problems | 1,66 | |
| 6 | 11 | **Unit 3: Guided waves**<br>• Introduction to guided waves<br>• Solving wave equation in non homogeneous media | X | | NO | NO | Resolution of proposed problems | 1,66 | 5 |
| 6 | 11 | **Lab 2.** Calculation of the standing wave diagram for a problem with normal incidence | X | X | Computers room from the UCIIIM | YES | To read and to prepare the Laboratory session. The student will calculate different examples of reflection and transmission of plane waves in several media. The code will be made by the student in MATLAB. | 1,66 | |
| 7 | 13 | *Individual Test (Units 1 and 2)* | X | | NO | NO | Self-study to prepare for the test | 1,66 | 6 |
| 7 | 14 | **Unit 3: Guided waves**<br>• TE, TM and TEM modes. Mode impedance..<br>• Propagation constant in guided waves<br>• Brillouin diagram. | | X | NO | NO | Studying the differences between plane waves and guided waves | 1,66 | |
| 8 | 15 | **Unit 3: Guided waves**<br>• Rectangular waveguide. Fundamental mode<br>• Cutoff frequency. Examples. | X | | NO | NO | Revision of the theory seen in the lectures. Solving examples of rectangular waveguide problems | 1,66 | 6 |
| 8 | 16 | **Unit 3: Guided waves**<br>• Dielectric losses in waveguides.<br>• Resolution of problems. | | X | NO | NO | Revision of the theory seen in the lectures. Resolution of proposed problems | 1,66 | |
| 9 | 17 | **Unit 3: Guided waves**<br>• Transmission lines: TEM modes.<br>• Characteristic impedance.<br>• Primary parameters | X | | NO | NO | Studying transmission line theory | 1,66 | 5 |
| 9 | 18 | **Unit 3: Guided waves**<br>• Resolution of problems | | X | NO | NO | Resolution of proposed problems | 1,66 | |
| 10 | 19 | **Unit 3: Guided waves**<br>• Transmission line ended by an impedance load. Input impedance.<br>Resolution of problems | X | | NO | NO | Revision of the theory seen in the lectures. Resolution of proposed problems | 1,66 | 5 |
| 10 | 20 | **Unit 3: Guided waves**<br>• Resolution of problems | | X | NO | NO | Resolution of proposed problems | 1,66 | |
| 11 | 21 | **Unit 4: Radiation**<br>• Introduction to electromagnetic radiation.<br>The small dipole. Radiation zones.*Individual* | X | | NO | NO | Studying radiation theory | 1,66 | 6 |

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| 11 | 22 | **Unit 3: Guided waves**<br>Resolution of problems | | X | NO | NO | Self-study to prepare for the test | 1,66 | |
| 12 | 23 | *Individual Test (Unit 3)* | X | | NO | NO | Self-study to prepare for the test | 1,66 | 6 |
| 12 | 24 | **Unit 4: Radiation**<br>• Antenna parameters: radiation pattern, directivity, efficiency.<br>• Antenna parameters: gain, impedance, polarization<br>• Exercises | | X | NO | NO | Studying antenna parameters. Resolution of proposed problems | 1,66 | |
| 13 | 25 | **Unit 4: Radiation.**<br>• Friis equation<br>• Element displaced from origin.<br>• Problems resolution | X | | NO | NO | Revision of the theory seen in the lectures. Resolution of proposed problems about Friis equation | 1,66 | 5 |
| 13 | 26 | **Lab 4.** Radiation: superposition of field radiated by identical antennas: introduction to arrays. | | X | Computers room from the UCIIIM | NO | | 1,66 | |
| 14 | 27 | *Individual Test (Unit 4)* **Unit 4: Radiation.**<br>• Introduction to arrays: Principle of superposition. Exercises | X | | NO | YES | Self-study to prepare for the test | 1,66 | 6 |
| 14 | 28 | *Common tutorship and review lecture* | | X | NO | NO | Studying all the chapters from the course | 1,66 | |
| 9 | 29 | **Lab 3.** Analysis of modes in a rectangular waveguide. Propagation modes and Brillouin Diagram | | | Computers room from the UCIIIM | YES | To read and to prepare the Laboratory session.The student will represent the field distribution of some modes in rectangular waveguides. | 1,66 | 1 |
| **SUBTOTAL** | | | | | | | | **48,33 + 77 = 125,33** | |

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| 16 | | Making-up classes, delivery of homework, office hours | | | | | | 5 | |
| 17 | | Preparing the evaluation and evaluation itself | | | | | | 4 | 20 |
| 18 | | | | | | | | | |
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| **TOTAL** *(Total 1 + Total 2. Max 180 hours)* | **Total 2** *(Teaching hours and student work in weeks 15-18)* | 29 |
| | | **154,33** |