Universidad Carlos III de Madrid

DENOMINACIÓN ASIGNATURA: Subsistemas de radiofrecuencia y antenas / Radiofrequency Subsystems and Antennas.		
MÁSTER: Ingeniería de Telecomunicación/Telecommunications Engineering	CURSO: 1º	CUATRIMESTRE: 1º

The course has 29 sessions distributed over 14 weeks. The labs can be scheduled during any of those weeks. Due to those 29 sessions, an additional session will be scheduled for one week, which will be at 1:00 PM in Puerta de Toledo and at 7:00 PM in Leganés. The classroom in Puerta de Toledo is the 0.A.08, while in Leganés is the 4.0.E06 (tbc) on Tuesdays, 3:00 PM and 4.1.E05 on Thursdays, 3:00 PM.
The 24-25 course will first cover the subsystems section and then the antennas section. The course can be passed through continuous assessment, provided that the average of the tests (excluding the practical work) is above 6.0 in each of the parts.
Sessions marked in blue are circuit sessions, while those marked in orange are devoted to antennas. Lab sessions are indicated in green.
There are some changes in certain sessions that are directly indicated in the schedule.
This schedule is common to both the Puerta de Toledo and Leganés groups (the "session" box indicates the corresponding day for each group).
In addition, there are 4 review sessions (marked in color) that will be held in Leganés in classroom 4.2.E02 and will be broadcast via BBC. These sessions will be 100 minutes long and will be recorded. The contents of these sessions will be: microwave passive circuits and introduction to antennas essential for students who have not previously taken the course, and recommended for the rest of the students) and use of circuit and antenna design software. The concepts that will be explained during these sessions are: concept of transmission line and Smith chart, S-parameters, microwave passive circuits and introduction to antennas. **Two review sessions on antennas will be held first.**

COURSE SCHEDULE							
WEEK	**SESSION**	**SESSION CONTENT DESCRIPTION**	Indicate space different than the classroom (e.g., computer lab, lab, etc.).	Indicate if it is a 2 - teacher session **(Note)**	**STUDENT WORK DURING WEEK**		
					DESCRIPTION	**In-person hours**	**Work hours (Max. 7,5 H)**
0	**Review 1** **Sept. 2: 17:00** **4:2:E03**	**Chapter 0.1: Waveguides and transmission lines; Smith chart. AWR.**			Review of TAF (GITT) contents, required for the course: TX lines and Smith chart.		
	Review 2 **Sept. 3: 11:00** **4:2:E03**	**Chapter 0.2: S-parameters and microwave circuits.**			Review of TAF (GITT) contents, required for the course: S-parameters and passive circuits.		
1	1 10 sep. PT: *0:A08* 10 sep. Le: 4:0:E06	**Chapter 1: Passive frequency conversion and control devices** 1.1. Description of transmitters and receivers in communications. 1.2. Diodes in microwaves: modelling 1.3. Basic concepts of mixing (part 1)	NO		Review of diode theory and basic concepts of mixing explained in class.	1,66	7
	2 13 sep. PT: *0:A08* 12 sep. Leg. 4:1:E05	**Chapter 1: Passive frequency conversion and control devices** 1.4. Basic concepts of mixing (part 2) 1.5. Diode-based mixers: fundamentals of mixing. 1.6. Single diode mixer circuit.	NO		Review of mixer theory explained in class.	1,66	
2	3 17 sep. PT: *0:A08* 17 sep. Le: 4:0:E06	**Chapter 1: Passive frequency conversion and control devices** 1.7. Single balanced mixers. 1.8. Diode-based detectors. 1.9. Exercises.	NO		Review of mixers and detectors theory explained in class.	1,66	7
	4 20 sep. PT: *0:A08* 19 sep. Leg. 4:1:E05	**Chapter 2: Microwave amplifiers** 2.1. BJT bipolar transistors in microwaves: modelling 2.2. MESFET transistors in microwaves: modelling 2.3. Introduction to microwave linear amplifiers. 2.4. Introduction: Bias in amplifiers.	NO		Review of transistors and microwave amplifiers theory explained in class.	1,66	
3	5 24 sep. PT: *0:A08* 24 sep. Le: 4:0:E06 24 sep. Leg. moved to 12 sept., 19:00:	**Chapter 2: Microwave amplifiers** 2.5. Amplifier gain and stability. 2.6. Constant gain circles. 2.7. Unilateral amplifiers. 2.8. Design of a specific-gain amplifier: Exercises: problem 1, part 1	NO		Review of microwave amplifier theory explained in class; exercises.	1,66	7
	6 27 sep. PT: *0:A08* 26 sep. Leg. 4:1:E05 26 sep. Leg, moved to 19 sept. 19:00	**Chapter 2: Microwave amplifiers** 2.8. Design of a specific-gain amplifier: Exercises: problem 1, continuation 2.9. Low-noise amplifiers and noise circles. 2.10. Conjugate gain circles. 2.11. Mismatching circles. Problem 4, part 1.	NO		Review of microwave amplifier theory explained in class; exercises. Lab session 1 previous work.	1,66	
	Review 3 **Sept. 27: 13:00** ***	**Chapter 0.3: AWR and passive microwave circuits.**	NO		Review of TAF (GITT) contents, required for the course: AWR and passive circuits.		

4	7 1 oct. PT: *0:A08* 1 oct. Leg: 4:0:E06	**Chapter 2: Linear microwave amplifiers** 2.11. Problem 4, continuation. 2.12. Design of a multi-stage amplifier. 2.13 Low-noise and specific-gain amplifiers exercises.	NO		Review of microwave amplifiers theory explained in class; exercises. Lab session 1 previous work.	1,66	7
	8 4 oct. PT: *0:A08* 3 oct. Leg. 4:1:E05	2.14. Multi-stage amplifiers exercises. 2.15. Amplifier measurement: gain (network analyzer) and noise.	NO		Review of microwave amplifiers theory explained in class; exercises. Lab session 1 previous work.	1,66	
	9 Sesión 29 3 oct. PT y Leg. (at 13:00 and 19:00 respectiv.)	Lab session 1: Design of a low-noise active antenna: 1) Mixer (session 1). It will be designed with AWR software	NO, virtual desktop		Mixer basic design. Electrical design optimization.	1,66	
5	10 8 oct. PT: *0:A08* 8 oct. Leg: 4:0:E06	**Chapter 3: Microwave oscillators** 3.1. Basic oscillator concepts. 3.2. Oscillators based in single-port devices: oscillation condition. 3.3. Stability in oscillators. 3.4. Design of a negative resistance oscillator. Exercise. 3.5. Transistor-based oscillators.	NO		Review of microwave oscillators theory explained in class, exercises. Test and exam preparation.	1,66	7
	11 11 oct. PT: *0:A08* 10 oct. Leg. 4:1:E05	**Chapter 3: Microwave oscillators** 3.6 Generalization of oscillation condition to N-ports networks. 3.7. Design of a transistor-based oscillator. 3.8. Oscillators based in dielectric resonator (DRO). 3.9. Design of a transistor-based oscillator and DRO. Exercises.	NO		Review of microwave oscillators theory explained in class, exercises. Test and exam preparation.	1,66	
6	12 15 oct. PT: *0:A08* 15 oct. Leg: 4:0:E06	**Chapter 3: Microwave oscillators** 3.10. Exercises **Test on everything covered (40 minutes, 20 questions), it will be ONLINE but in-person**	NO		Review of microwave oscillators theory explained in class, exercises. Exam preparation.	1,66	7
	13 18 oct. PT: *0:A08* 17 oct. Leg. 4:1:E05	Lab session 2: Design of a low-noise active antenna: 1) Low-noise amplifier (session 2).It will be designed with AWR software.	NO, virtual desktop		Basic design of a low-noise amplifier. Electrical design optimization. Lab report submission: 5 dec. 14:00.	1,66	
7	14 22 oct. PT: *0:A08* 22 oct. Leg: 4:0:E06	**Chapter 4: Fundamentals and radiation parameters.** 4.1. Radiation mechanism. 4.2. Antenna types. 4.3. Antenna fundamental parameters. Exercises.	NO		Review of the basic antenna theory and exercises proposed in class. Continuation of the electrical circuit for the lab. Active devices exam preparation.	1,66	7
	15 25 oct. PT: *0:A08* 24 oct. Leg 4:1:E05	**Chapter 4: Fundamentals and radiation parameters. Review.** 4.4 Equivalence and uniqueness theorems. 4.5 Link budget and exercises on radiation parameters.	NO		Review of the basic antenna theory and exercises proposed in class. Continuation of the electrical circuit for the lab. Active devices exam preparation.	1,66	
	Review 4 **Oct. 25: 13:00** **online**	**Chapter 0.4: fundamental antenna parameters and CST.**			Review of basic antenna parameters explained in EM Fields (GITT) and introduction to simulation SW.		
8	16 **29 oct. 13:00** **Leganés y PT**	**Individual exam: chapters 1, 2 and 3.** **Contents can be exempted if the grade is above 6 (without the lab).**	YES			1,66	7

	17 31 oct. PT: *0:A08, 13:00* 31 oct. Leg. 4:1E05	**Chapter 4: Fundamentals and radiation parameters. Review** 4.6. Noise temperature in antennas. 4.7 Exercises.	NO		Review of the basic antenna theory and exercises proposed in class. Circuit layout definition.	1,66	
9	18 5 nov. PT: *0:A08* 5 nov. Leg: 4:0:E06	**Chapter 5: Radiation integrals and auxiliar potential functions.** 5.0. Introduction to radiation integrals. 5.1. Retarded potentials. 5.2. Radiation vectors. 5.3. Fresnel and Fraunhofer regions.	NO		Review of the basic antenna theory and exercises proposed in class. Circuit layout definition.	1,66	7
	19 8 nov. PT: *0:A08* 7 nov. Leg 4:1:E05	Lab: low-noise amplifier integration (session 3) and pre-design of a patch antenna.	NO, virtual desktop	2 teachers	Practical explication of simulation SW. Lab preparation from this explanation. Some designs may be manufactured. Report submission: 5 dec., 23:59.	1,66	
10	20 12 nov.. PT: *0:A08* 12 nov. Leg: 4:0:E06	**Chapter 5: Radiation integrals and auxiliar potential functions.** 5.4. Range of measurement determination. 5.5. Equivalence, uniqueness and reciprocity theorems. **Chapter 6: Elementary antennas.** 6.1 Elementary wire antennas. 6.2. Elementary loop antennas.	NO		Review of elementary antennas theory and exercises proposed in class. Preparation of antenna lab.	1,66	7
	21 15 nov. PT: *0:A08* 14 nov. Leg 4:1:E05	**Chapter 6: Elementary antennas.** 6.3. Dipole antennas and resonant antennas. 6.4 Image theory 6.5 Monopoles 6.6 Exercises	NO		Review of elementary antennas theory and exercises proposed in class. Preparation of antenna lab.	1,66	
11	22 19 nov. PT: *0:A08* 19 nov. Leg: 4:0:E06	**Chapters 4, 5 and 6: Antennas exercises.** **Chapter 7: Antenna arrays.** 7.1. Radiated fields by arrays.			Review of elementary antennas theory and exercises proposed in class. Preparation of antenna lab.	1,66	7
	23 22 nov. PT: *0:A08* 21 nov. Leg. 4:1:E05	**Chapter 7: Antenna arrays.** 7.2. Radiation diagram of arrays. 7.3. Typical current distributions.	NO		Review of elementary antennas and arrays theory explained, and exercises proposed in class. Preparation of antenna lab.	1,66	
	24 22 nov. PT: *0:A08* 21 nov. Leg: 4:0:E06 13:00 and 19:00. Moved to 12 and 13 dic in Leg.	Lab session 4: Design of a linear planar antenna: patch. It will be designed with CST software	SI	2 teachers	**2 teachers** Practical explication of simulation SW. Lab preparation from this explanation. Some designs may be manufactured. Report submission: 5 dec., 23:59.	1,66	
12	25 26 nov. PT: *0:A08* 26 nov.Leg: 4:0:E06	**Chapter 7: Antenna arrays.** 7.4. Arrays directivity. 7.5 Exercises.	NO		Review of elementary antennas and arrays theory explained, and exercises proposed in class. Preparation of antenna lab.	1,66	7
	26 29 nov. PT: *0:A08* 28 nov. Leg. 4:1:E05	**Chapter 7: Antenna arrays.** 7.6. Planar arrays. 7.7. Arrays feeding. 7.8. Introduction to arrays synthesis. 7.9. Exercises	NO		Review of elementary antennas and arrays theory explained, and exercises proposed in class. Preparation of antenna lab.	1,66	

	Optional subject to prior coordination with the teacher 29 nov. PT, 13:00 28 nov. Leg, 19:00	Lab session 5: Location using a portable radar system	SI	2 teachers	Lab preparation from the theory explained in class. Report submission: 24 nov.		
13	27 3 dic. PT: *0:A08* 3 dic. Leg: 4:0:E06	**Chapter 7: Antenna arrays** 7.9 Exercises. **Chapter 8: Aperture antennas** 8.1 Introduction to aperture antennas. 8.2 Elementary apertures.	NO		Review of elementary antennas and arrays theory explained, and exercises proposed in class. Preparation of antenna lab.	1,66	7
	28 5 dic. PT: *0:A08, 13:00* 5 dic. Leg. 4:1:E05	**Antenna test, including arrays (40 minutes) it will be ONLINE but in-person.** **Chapter 8: Aperture antennas** 8.3 Horn antennas. 8.4 Horn antennas exercises. 8.5 Introduction to reflectors.	NO		Review of elementary antennas and arrays theory explained, and exercises proposed in class. Preparation of antenna lab. Report submission: 5 dec., 23:59.	1,66	
14	29 10 dic. PT: *0:A08* 10 dic. Leg: 4:0:E06	**Chapter 8: Aperture antennas** 8.6. Exercises			Review of elementary antennas and arrays theory explained, and exercises proposed in class. Preparation of antenna lab.	1,66	7
	Exam 12 dec, 13:00, two groups simultaneously	**Individual exam on antennas: chapters 4, 5, 6, 7 and 8** **Contents can be exempted if the grade is above 6 (without the lab).**			Review of theory explained in class. Exercises.	1,66	
SUBTOTAL						**48,14 +105**	**= 153,14**
16		Preparation of final exam on January, 23rd.					23
17							
TOTAL						**180**	

(*) El número de sesiones con 2 profesores o de laboratorios experimentales en grupos de 20 alumnos estará comprendido entre un mínimo de 2 y un máximo de 6. Además, al menos 2 de estas sesiones se celebrarán fuera del horario regular, para lo cual se debe rellenar la tabla que aparece más abajo CRONOGRAMA LABORATORIOS EXPERIMENTALES.

(**) 105 horas de trabajo del alumno como máximo en 15 semanas, suponiendo 30 horas por crédito ECTS.

Course organization and evaluation.

The course will be assessed through continuous assessment. The continuous assessment consists of:

1) Practical exercise distributed in 4 sessions. It has a weighting of 15%
2) Mid-term exam on active circuits. Contents can be exempted if and only if the average grade of the active circuits part is above 6. Both groups will be evaluated on October 29th, and it weighs 15%
3) Contents can be exempted if and only if the average grade of the active circuits part is above 6. Both groups will be evaluated on December 12th, and it weighs 15%.
4) There are two mid-term tests with a weight of 10%.
5) Final exam with a 45% weighting.

Final grade

The final grade will be obtained as:

A) Students with a grade above 6/10 in the continuous assessment of both parts (active devices and antennas, without the lab): the grade will be weighted 85% and added to the lab grade multiplied by 0.15. These students can improve their grade in the final exam.
B) Students with a grade below 6/10 in one of the parts of the continuous assessment: they are exempted of the other part and they only have to do the final exam on this part, requiring a minimum grade of 4.5 to average with the exempred part. The final grade in this case will be: exempted part*0,425+0,20*cont. assessment no exempted + 0,225 final exam no exempted.
C) Students below 6/10 in the continuous assessment: 55% of the continuous assessment plus 45% of the final exam. A minimum grade of 4.0 is required to average with the continuous assessment.
D) The optional lab and the active participation in the problem forum plus the realization of a podcast for this forum can improve the grade up to 1 point, provided that the minimum grade in all the parts has been achieved.