

International Master's Degree Programme in Wireless Communication Engineering (WCE)

Curriculum for WCE-RAN and WCE-RF Study Options 2019-2021

1. Structure of WCE Studies

The [Centre for Wireless Communications](#) (CWC) at the [Faculty of Information Technology and Electrical Engineering](#) (ITEE), [University of Oulu](#) is responsible for organizing the 2 years international master's degree programme (IMP) of [Wireless Communication Engineering](#) (WCE). WCE programme offers two study specialization options: Radio Access Networks (WCE-RAN) and RF Engineering (WCE-RF). Student has selected either programme already in IMP admission phase on spring.

In addition, CWC arranges a double degree (DD) programme in WCE (DD-WCE) together with the Asian Institute of Technology (AIT, Bangkok, Thailand, <https://www.ait.ac.th/>) and the University of Peradeniya (UoP, Peradeniya, Sri Lanka, <https://www.pdn.ac.lk>). Curriculum courses of the DD-WCE is organized together with AIT and UoP partners. Detailed curriculums for DD-WCE IMP can be found from the page: <http://www.oulu.fi/cwc/ddwcecurriculum>.

- [https://www.oulu.fi/sites/default/files/content/Curriculum for the students coming from the UoP_0.pdf](https://www.oulu.fi/sites/default/files/content/Curriculum%20for%20the%20students%20coming%20from%20the%20UoP_0.pdf)
- [https://www.oulu.fi/sites/default/files/content/Curriculum for the students coming from the AIT.pdf](https://www.oulu.fi/sites/default/files/content/Curriculum%20for%20the%20students%20coming%20from%20the%20AIT.pdf)

This curriculum covers only WCE-RAN and WCE-RF study options. WCE programme consist of 120 ECTS credits of studies based on the modules described below. 60 ECTS credits measure the workload of a full-time student during one academic year, which equals around 1500-1800 hours per year. Thus one ECTS credit stands for 25-30 working hours. The structure of WCE studies is organized according to the figure on next page.

All WCE courses are implemented in English. Execution of the WCE programme consist of passing the courses contained in the *basic*, *advanced* and *optional* (elective studies) modules. All courses within the basic and advanced modules must be completed. There is freedom to choose elective courses for the optional module based on student's interest. 12-17 ECTS of elective studies - depending of study options RAN and RF - must be chosen. That's why the minimum and maximum number of credit points in advanced and optional modules varies a within the limits shown above.

In addition, master's thesis theses work (30 ECTS equals roughly 6 month workload) and advanced practical training (3 ECTS equals roughly 2 month workload) are obligatory.

Mandatory WCE courses in basic and advanced modules are offered by the [Centre for Wireless Communications](#) and [Circuits and Systems](#) (CAS) research units. Most of elective courses are offered by other [ITEE](#) faculty units seen on the page: <http://www.oulu.fi/itee/units>. Finnish language studies are offered by the [UO Language & Communication unit](#). Course syllabuses of all UO degree programmes (given both in Finnish and English) can be found from: <https://weboodi.oulu.fi/oodi/opasopiskopas.jsp>

Student can include elective courses into his/her optional studies module (elective studies) even from other units & faculties of Oulu University, provided they are accepted into student's personal study plan (PSP) by the personal study advisor (academic coordinator, and chair of WCE programme Dr. Kari Kärkkäinen). *Always consult your personal study advisor before including elective courses offered by other faculties into your personal study plan, or before starting to listen a course. Such courses can be found from: <https://weboodi.oulu.fi/oodi/opasopiskopas.jsp>.* Courses from CWC, and other ITEE research units can be included directly into your PSP without consulting your study advisor (see the list for such elective studies in Chapter 4).

Basic WCE studies (RAN: 40, RF: 36 ECTS)
Advanced WCE studies (RAN: 30, RF: 36/37 ECTS)
Optional WCE studies (RAN: ≥ 17 , RF: $\geq 12/13$)
Advanced practical training (3 ECTS)
Master's (Diploma) Thesis work (30 ECTS)
In total 120 ECTS

ECTS = European Credit Transfer System, 1 credit 25-30 hours, 1 year ca. 60 credits

If a student fails to pass an exam, she/he can try again on next final exam date of that course. Typically 3-4 exams are arranged per year for each course (depending on whether summer exams are arranged or not). *Notice, no restrictions are imposed on the number and the time-span of taken exams for each course, i.e., if you fail an exam, you can retry during next exams, or next study year without a need to listen again the course on next year.* Also, if you are not satisfied with your grade, you can try to upgrade your grade in next exams without restrictions. *Exams are always written with a pencil.* Use of permanent ink pen is not obligatory, and it is not recommended.

Each WCE student has to submit an electronic personal study plan (PSP) to the programme's personal study advisor Dr. Kari Kärkkäinen for approval at the beginning of studies (typically in October-November). Instructions session for creation of a PSP will be arranged at the beginning of autumn term. PSP is prepared with the aid of OodiPSP under [Weboodi environment](#). Take a look at the OodiPSP instructions on the page: <http://www.oulu.fi/cwc/node/11468>.

2. General Issues Dealing with Studies

Academic study year at UO is divided into 4 periods. Periods 1, and 2 run on autumn (A) term, and periods 3 and 4 run on spring (S) term. Time span for each period is 7-8 weeks. Final exams are arranged at the end of each period. Mid-term exams or weekly-based mini-exams are organised for some courses. Each study year consists of approximately 32 weeks of teaching. Between 2nd and 3rd periods there is a season break for the Christmas & New Year between 21.12.2019...6.1.2020 (weeks 52-1). No teaching and exams are arranged during that holiday season. Then it is possible to visit in your home country.

Studies begin on week 36 with training period 2.9.-6.9.2019 and first lectures of each course. It is very important for students to arrange their residence permit issues, book flights and accommodation so that they can arrive on weekend 31.8.-1.9.2019 at the latest. Otherwise they will miss a lot of crucial instructions and information dealing with their studies and study practices at UO in order to get started.

The exact dates for the periods of the study year 2019-2020 are the following: 1st: 2.9.-25.10.2019 (weeks 36-43) , 2nd: 28.10.-20.12.2019 (weeks 44-51), 3rd: 7.1.-6.3.2020 (weeks 2-10), 4th: 9.3.-8.5.2020 (weeks 11-19). Summer brake is between 11.5...30.8.2020.

Extra summer exams are typically arranged in summer time. Mandatory advanced practical training course of 3 ECTS credits is recommended to be done during summer season after 1st study year. Training period of 3 ECTS equals 2 month full-time workload.

At the beginning of studies during the orientation week a WCE student will get his/her personal UO e-mail account, and a licenses to use UO computer networks, i.e. will get UID & PW for UO computer systems. Those computer systems are needed in executing exercise and design works contained in most courses of WCE curriculum, as well as, to access lecture and exercise materials stored in pdf-format either into [OPTIMA](#) environment, or into [MOODLE](#) environment. Old Optima environment will be terminated on 31.7.2020, and new Moodle is already in use. *Notice, depending on course instructor, materials of each course may locate in either Optima or Moodle environment.* Instructor will tell in his/her first lecture which system is used in that course.

3. Computer Environments and Study Portals in UO Computer Network

After enrolling to Oulu University in September, student will get personal userID & password for UO IT service's computer network needed in studies. It is called *paju account* or briefly just *account*, and student will get an unique **pajuID**. Student needs *account* when using [OPTIMA](#), [MOODLE](#), [WEBOODI](#), [TUUDO](#) , and O365 study portals. TUUDO is an application used in a smart phone. All study portals that will be explained briefly below, and student tutors (Kummis) help students to get started.

Students will also get their personal UO e-mail address & service for the Microsoft's **Office 365 for Education (O365)** cloud service: <http://o365.oulu.fi/>. Office 365 for Education (O365) will offer our students a free Outlook e-mail, and free cloud services like Office Online applications (Word, Excel, PowerPoint, OneNote), calendar and OneDrive.

Student's specific e-mail address will be told when student enrolls to university. Typically those are in forms *account@student.oulu.fi*, or *firstname.familyname@student.oulu.fi*, although not limited those if students with same name exists at UO. More about UO IT administration services can be found from: <http://www.oulu.fi/ict/>. There you can also find a list of links for all UO student environments. Student restaurants and their menus can be found from Juvenes company's web page: <https://www.juvenes.fi/oulu/en>. Web page of Finnish student



health service (FSHS/YTHS) offering medical doctor and dentist services is: <https://www.yths.fi/en>. PSOAS housing company offering student dormitories can be found from: <https://www.psoas.fi/en/>.

All official correspondence from academic coordinator, UO teachers and student service officers is communicated only with using student's O365 system e-mail address. Although you may prefer your personal e-mail system (Gmail, Yahoo, Hotmail, etc.), UO personnel does not use your personal e-mail address in matters dealing with your studies. **That's why remember every now and then check your O365 e-mail account in order not to miss important messages from teachers, etc., and/or forward UO mails to your personal account.**

Detailed instructions how to activate the UO O365 service can be found from the web page: <http://www oulu fi/ict/office365>.

Course materials are typically stored into the TTK-OPTIMA portal: <https://optima oulu fi/>. OPTIMA is an interactive study environment and two-way communication channel between student and teacher in order to share study materials and work assignments, and to discuss with teachers and colleague students. New system replacing OPTIMA by 31.7.2020 is MOODLE

WEBOODI (<https://weboodi oulu fi>) is an environment where all official detailed course descriptions including course books, timing periods, mode of delivery and requirements are located. Final marks of completed courses will be stored, and will appear there. Weboodi is a “mother” of all study-related systems at our university, under which all other environments are located and from which all information is fetched.

Students have to register with WEBOODI for courses before course starts, and also for final exams. When registering to an exam using WEBOODI student always has to ask exam questions in English. Failing to register means that student cannot participate an exam! Registration period expires week before each final exam. Late registration beggings are not taken in account!

TUUDO (<https://www.tuudo.fi/en/>) is a course calendar containing main information needed in studies during each day. Each WCE student should create into her/his smart phone own electronic TUUDO lecture & exercise calendar containing dates, times and rooms of her/his courses for each period of academic year 2019-2020, notifications, UO maps, restaurant menus, etc.. Also registrations and passed credits will appear there. **Uploading of TUUDO application is one of the first tasks to be done after student's arrival.** TUUDO will pick up all timing & room information directly from the Weboodi system. Introduction to TUUDO pages:

- <http://www oulu fi/university/node/42359>
- <https://www.tuudo.fi/en/>

LATURI (<https://laturi oulu fi/index.php?uilang=en-US>) is an environment which loads student's ready master's thesis in pdf-A form for inspection to indicate possible plagiarism contained in a thesis.

URGUND (<http://www.orkund.com/fi/>) checks student's master's thesis (feeded with LATURI) revealing plagiarism.

Personal student tutors (Kummi) will advise students at the beginning of studies how to use these study environments. Students should not worry, since they will learn them easily.

4. Curriculum Schedule for Academic years 2019-2021 of WCE Students

4.1 WCE Radio Access Networks Study Option (WCE-RAN)

Code and link to the WebOodi	Name of the course	Recommended timing							
		1. study year				2. study year			
		autumn		spring		autumn		spring	
		1P	2P	3P	4P	1P	2P	3P	4P
	Radio access networks study option, basic module 40 ECTS, all obligatory								
031051S	Numerical matrix analysis	5	5						
521348S	Statistical signal processing I	5	5						
521395S	Wireless communications I	5	5						
031025A	Introduction to optimization	5		5					
521340S	Communications networks I	5		5					
521324S	Statistical signal processing II	5			5				
521349S	Wireless communications II	5			5				
521326S	Radio engineering I	5					5		
	Radio access networks study option, advanced module 33 ECTS, choose at least 30 ECTS + advanced practical training								
521016A	Advanced practical training	3			0	3	0		
521386S	Radio channels	5		5					
521369A	Simulations and tools for telecommunications	5		5					
521327S	Radio engineering II	6						0	
521377S	Communications networks II	7			0	0			
521388S	Antennas	5				5			
521279S	Signal processing systems	5					5		
521322S	Telecommunication engineering project or	5					0	5	
521300S	Electronics design and construction exercise	6					0	0	
521318S	Modern topics in telecommunications and radio engineering	3-7					0	0	0
521389S	Wireless body area networks ^{*)}	5			5				
521325S	Communications signal processing ^{**)}	5							0
521390S	Information theory ^{*)}	5					0		
521391S	Channel coding and modulation ^{**)}	5					0		
521392S	Convex optimization ^{*)}	7					0	0	
521393S	Statistical communication theory ^{*)}	7					0	0	
521394S	Multiantenna communications ^{**)}	5					0		
	^{*)} will be lectured in even years (2020, 2022,...)								
	^{**)} will be lectured in odd years (2021, 2023,...)								
	0 = period when course is taught/can be taken/is suggested to be taken								

Code and link to the WebOodi	Name of the course	Recommended timing								
		1. study year				2. study year				
		autumn		spring		autumn		spring		
		1P	2P	3P	4P	1P	2P	3P	4P	
	Optional courses needed from language center or other units ≥ 17 ECTS				2	10	5			
900017Y	Survival Finnish Course	2	0			0				
900013Y	Beginners Finnish Course I	3		0			0			
900053Y	Beginners Finnish Course II	5			0			0		
521225S	RF components and measurements	5							0	
521097S	Wireless measurements	5						0		
813621S	Research methods	5						0	0	
521273S	Biosignal processing I						0			
521282S	Biosignal processing II	5							0	
521467A	Digital image processing	5							0	
521145A	Human computer interaction	5					0			
521045S	Mobile computing	5						0	0	
521043S	Internet of things	5							0	
521140S	Computer graphics	5							0	
521290S	Distributed systems	5							0	
521466S	Machine vision	5							0	
521156S	Towards data mining	5				0				
521260S	Programmable web project	5						0	0	
521479S	Software project	7				0	0			
521283S	Big data processing and applications	5							0	
521158S	Natural language processing and data mining	5					0			
521289S	Machine learning	5						0		
521161S	Multi-modal data fusion	5					0			
521285S	Affective computing	5				0				
521153S	Deep learning	5					0			
521155S	Computer security	5				0				
521495A	Artificial intelligence	5						0		
521042S	Creative design	5				0				
521288S	Multi-processor programming	5						0	0	
521042S	Application specific signal processors	5				0				
521423S	Embedded system project	5						0	0	
521998S	Master's thesis (Telecommunication Engineering)	30						15	15	
521011S	Maturity essay and seminar									
	Number of ECTS / period		15	20	10	15	10	20	15	15
	Number of ECTS / semester		35		25		30		30	
	Number of ECTS / study year		60				60			
	Number of ECTS / degree		✓ 120							

With the elective courses of an optional module a student can extend his/her knowledge from wireless communications, e.g., into the areas of practical electronics design, wireless measurement techniques, computer science & engineering, and Information processing science. Student is anyway free to choose the elective courses she/he likes. She/he has to choose elective courses depending on how many credits must be chosen into advanced module. Course syllabuses of all UO degree programmes (given both in Finnish and English) can be found from: <https://weboodi oulu.fi/oodi/opasopiskopas.jsp>

Student can also do more courses than the minimum ECTS requirement if she/he wish. *It is also possible to include at most 10 ECTS of Finnish language studies into optional module.* Finnish language studies are recommended for all WCE students, especially during first study year, in order to integrate with Finnish society, and fellow Finnish students in a classroom. Basic Finnish vocabulary is useful in daily life, although most Finnish people speak satisfying English outside our campus. Elective studies could be consisted e.g. from the following list of optional studies.

4.2WCE Radio Engineering Study Option (WCE-RF)

Code and link to the WebOodi	Name of the course	Recommended timing							
		1. study year				2. study year			
		autumn		spring		autumn		spring	
		1P	2P	3P	4P	1P	2P	3P	4P
	Radio engineering study option, basic module 36 ECTS, all obligatory								
521401S	Electronics design II	6	6						
521348S	Statistical signal processing I	5	5						
521395S	Wireless communications I	5	5						
521326S	Radio engineering I	5		5					
521324S	Statistical signal processing II	5		5					
521225S	RF components and measurements	5			5				
521405A	Electronic system design	5				5			
	Radio engineering study option, advanced module 41/42 ECTS, obligatory from these total 36/37 ECTS								
521435S	Electronics design III	6	6						
521327S	Radio engineering II	6		6					
521075S	Microelectronics packaging technologies	5		5					
521388S	Antennas	5			5				
521402S	Telecommunications circuit design	6				6			
521322S	Telecommunication engineering project or	5				0	5		
521300S	Electronics design and construction exercise	6				0	0		
521016A	Advanced practical training	3		0	3	0			
	Optional courses, 5 ECTS								
521386S	Radio channels	5	5						
521328A	Simulations and tools for telecommunications	5	0						
521340S	Communications networks I	5	0						
521349S	Wireless communications II	5		0					
521318S	Modern topics in telecommunications and radio engineering	3-7				0	0	0	0
521325S	Communications signal processing ^{**})	5							0
	^{**}) will be lectured in odd years (2021, 2023,...)								
	0 = period when course is taught/can be taken/is suggested to be taken								

Code and link to the WebOodi	Name of the course	Recommended timing								
		1. study year				2. study year				
		autumn		spring		autumn		spring		
		1P	2P	3P	4P	1P	2P	3P	4P	
	Optional courses needed from language center and other units $\geq 12/13$ ECTS					3	10			
900017Y	Survival Finnish Course	2	0			0				
900013Y	Beginners Finnish Course I	3		0			0			
900053Y	Beginners Finnish Course II	5			0			0		
521097S	Wireless measurements	5						0		
813621S	Research methods	5						0	0	
521273S	Biosignal processing I						0			
521282S	Biosignal processing II	5							0	
521467A	Digital image processing	5							0	
521145A	Human computer interaction	5					0			
521045S	Mobile computing	5						0	0	
521043S	Internet of things	5							0	
521140S	Computer graphics	5							0	
521290S	Distributed systems	5						0		
521466S	Machine vision	5						0		
521156S	Towards data mining	5				0				
521260S	Programmable web project	5						0	0	
521479S	Software project	7				0	0			
521283S	Big data processing and applications	5							0	
521158S	Natural language processing and data mining	5					0			
521289S	Machine learning	5						0		
521161S	Multi-modal data fusion	5					0			
521285S	Affective computing	5				0				
521153S	Deep learning	5					0			
521155S	Computer security	5				0				
521495A	Artificial intelligence	5						0		
521042S	Creative design	5				0				
521288S	Multi-processor programming	5						0	0	
521042S	Application specific signal processors	5				0				
521423S	Embedded system project	5						0	0	
522991S	Master's thesis (RF engineering)	30						15	15	
521011S	Maturity essay and seminar									
	Number of ECTS / period		16	16	16	13	14	15	15	
	Number of ECTS / semester		32		29		29		30	
	Number of ECTS / study year		61				59			
	Number of ECTS / degree		✓ 120							

With the elective courses of an optional module a student can extend his/her knowledge from wireless communications, e.g., into the areas of practical electronics design, wireless measurement techniques, computer science & engineering, and Information processing science. Student is anyway free to choose the elective courses she/he likes. She/he has to choose elective courses depending on how many credits must be chosen into advanced module. Course syllabuses of all UO degree programmes (given both in Finnish and English) can be found from: <https://webodi.oulu.fi/oodi/opusopiskopas.jsp>

Student can also do more courses than the minimum ECTS requirement if she/he wish. ***It is also possible to include at most 10 ECTS of Finnish language studies into optional module.*** Finnish language studies are recommended for all WCE students, especially during first study year, in order to integrate with Finnish society, and fellow Finnish students in a classroom. Basic Finnish vocabulary is useful in daily life, although most Finnish people speak satisfying English outside our campus. Elective studies could be consisted e.g. from the following list of optional studies.

4.3 Internship and Master's Thesis Work

After first study year an obligatory [521016A](#) Advanced Practical Training course of two months workload is recommended to be done between June-August period of summer 2020. At the end of training period in September 2020 a training report must be submitted in order to get 3 ECTS credits for it. Forms and instructions for creating a training report can be found from the page:

<https://www.oulu.fi/cwc/node/11470>

When starting your obligatory master's thesis work you have officially apply a topic and plan a schedule for your work duration of 6 months. Also a chief professor/docent level supervisor, second examiner and practical supervisor are defined then by degree committee. Thesis application form can be found from the page:

[https://www.oulu.fi/sites/default/files/content/Masters thesis application form_0.rtf](https://www.oulu.fi/sites/default/files/content/Masters%20thesis%20application%20form_0.rtf)

All instructions about master's thesis work, forms, templates, and master's thesis guide can be found from the page:

<https://www.oulu.fi/eeng/node/6987>

At the end of studies a written master's thesis work must be done and it has to be loaded into [LATURI](#) for [URGUND](#) plagiarism check.

All detailed course descriptions, learning outcomes and detailed content of all WCE courses can be found in electronic form by from the WEBOODI portal:

<https://weboodi.oulu.fi>

Course materials for the purpose of studies are stored either in OPTIMA, or in MOODLE portals:

<https://optima.oulu.fi/>

<https://moodle.oulu.fi/>

All WCE curriculum documents, forms, templates, etc. can be found in one place from here:

<http://www.oulu.fi/cwc/wce>

which is the most important storage of WCE programme's information storage for the purpose of your studies. **Bookmark it now!**

If you do not understand something in curriculum, just stop by your programme's coordinator Dr. Kari Kärkkäinen's office to get easiest help for your problems.