ASIIN Seal & Euro-Inf® Label

Accreditation Report

Bachelor's Degree Program
Informatics Engineering

Master's Degree Programs
Informatics Engineering
Innovation and Research in Informatics

Provided by
Universitat Politècnica de Catalunya (UPC), Facultat d'Informàtica de Barcelona (FIB)

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A About the Accreditation Process

Name of the degree program (in original language)	(Official) English translation of the name	Labels applied for [1]	Previous accreditation (issuing agency, validity)	Involved Technical Committees (TC)[2]
Grau en Enginyeria Informàtica (GEI)	Bachelor in Informatics Engineering	ASIIN, Euro-Inf® Label	30.09.2016 – 30.09.2021	04
Màster universitari en Enginyeria Informàtica (MEI)	Master in Informatics Engineering	ASIIN, Euro-Inf® Label	30.09.2016 – 30.09.2021	04
Master in Innovation and Research in Informatics (MIRI)	Master in Innovation and Research in Informatics (MIRI)	ASIIN, Euro-Inf® Label	30.09.2016 – 30.09.2021	04
Date of the contract: 17.03.2021 **Submission of the final version of the self-assessment report:** 19.04.2021 **Date of the onsite visit:** 11.06.2021, online				
Peer panel: <u>For ASIIN:</u> Prof. Dr. Jacobo Torán, Ulm University Prof. Dr. Carsten Vogt, Cologne University of Applied Sciences <u>For AQU:</u> Prof. Dr. Juan Manuel Corchado Rodriguez, Univesity of Salamanca Prof. Dr. Santiago Escobar, University of Valencia Esther Andrés Pérez, Instituto Nacional de Técnica Aeroespacial (INTA) Alberto Álvarez, University of Coruña				

[1] ASIIN Seal for degree programs; Euro-Inf®: Label European Label for Informatics
[2] TC: Technical Committee for the following subject areas: TC 04 - Informatics/Computer Science

Representative of the ASIIN headquarter: Sophie Schulz	
Responsible decision-making committee: Accreditation Commission	
Criteria used: European Standards and Guidelines as of May 15, 2015 ASIIN General Criteria, as of December 10, 2015 Subject-Specific Criteria of Technical Committee 04 – Informatics/Computer Science as of March 29, 2018	

B Characteristics of the Degree Programs

a) Name	Final degree (original/English translation)	b) Areas of Specialization	c) Corresponding level of the EQF[3]	d) Mode of Study	e) Double/ Joint Degree	f) Duration	g) Credit points/ unit	h) Intake rhythm & First time of offer
Informatics Engineering	Enginyer Tècnic en Informàtica; B.Sc. in Informatics Engineering	Computer engineering, Computing, Information systems, Information technology, Software engineering	6	Full time, part time	/	8 semesters	240 ECTS	405 per year; 2010-2011
Informatics Engineering	Enginyer en Informàtica; M.Sc. in Informatics Engineering	/	7	Full time, part time	/	3 semesters	90 ECTS	50 per year; 2010-2011
Innovation and Research in Informatics	M.Sc. in Innovation and Research in Informatics	Advanced computing, Computer graphics & virtual reality, Computer networks & distributed systems, Data science, High performance computing	7	Full time, part time	/	4 semesters	120 ECTS	80 per year; 2010-2011

For the Bachelor's degree program Informatics Engineering the institution has presented the following profile in the self-assessment report:

„The Bachelor Degree in Informatics Engineering (GEI) provides graduates with all required knowledge, skills and competences to work in the field of Informatics Engineering. GEI offers a solid training in the fundamentals of informatics engineering complemented with an advanced training in one of the five recognised areas of Informatics defined by international professional associations: Computer Engineering, Computer Science, Information Systems, Information Technology and Software Engineering."

For the Master's degree program Informatics Engineering the institution has presented the following profile in the self-assessment report:

„The Master's Degree in Informatics Engineering (MEI) provides its graduates with the knowledge and hands-on experience in a wide range of information technology fields: from cloud computing to security, from computer graphics to information systems, with a focus

[3] EQF = The European Qualifications Framework for lifelong learning

on IT management and leadership. Graduates become the “Swiss Army knife” of IT in the organisations where they work.“

For the Master’s degree program Innovation and Research in Informatics the institution has presented the following profile in the self-assessment report:

„The Master in Innovation and Research in Informatics (MIRI) is designed to provide a solid background in different aspects of research in informatics, while preparing its graduates to become experts in any of the fields of specialisation offered. MIRI offers 6 areas of expertise: advanced computing, computer graphics and virtual reality, computer networks and distributed systems, data science (it has been replaced by a new Master in Data Science), high performance computing and service engineering (not currently taught).

C Peer Report for the ASIIN Seal[4]

1. The Degree Program: Concept, content & implementation

Criterion 1.1 Objectives and learning outcomes of a degree program (intended qualifications profile)

Evidence:

- Website per program, where detailed lists of competences are published
- Diploma Supplement
- Self-assessment report
- Discussions during the online audit

Preliminary assessment and analysis of the peers:
For all three study programs, the university presents a detailed description of general program goals in the self-assessment report (SAR) and, in particular, on each program's website. The peers approve that for each program a detailed presentation of learning outcomes and graduates' attributes is given in combination with learning outcome matrices matching the described learning outcomes with the respective modules of the programs. The very informative websites contain brief but explicit descriptions of the programs objectives, clearly stating the professional fields and specializations of the offered degree programs as well as programs particularities. The peers acknowledge that the learning outcomes and curricula of all programs were developed and are adapted jointly with students, alumni and industry representatives.

The university has aligned the program objectives with the subject-specific criteria of ASIIN and the Euro-Inf® standards. With respect to the bachelor's program Informatics Engineering, the peers approve that students gain knowledge and comprehension of essential facts, concepts, principles and theories related to informatics and their disciplines of reference. At the end of their studies, students should be able to interpret, select and value concepts,

[4] This part of the report applies also for the assessment for the European subject-specific labels. After the conclusion of the procedure, the stated requirements and/or recommendations and the deadlines are equally valid for the ASIIN seal as well as for the sought subject-specific label.

theories, uses and technological developments related to computer science and its application derived from the needed fundamentals of mathematics, statistics and physics. Furthermore, students should have acquired broad mathematical basics and the capacity to solve mathematical problems presented in engineering. The students are also expected to have a fundamental understanding of algorithms, data structures, problem solving patterns and computer architecture, enabling them to contribute to the solution of complex informatics problems.

Graduates of the master's program Informatics Engineering shall have a profound knowledge of the principles of informatics rooted in mathematical theory and have the capacity for critical, logical and mathematical reasoning. During their studies, students should gain analysis, design and implementation competences as well as extensive problem solving skills. They shall be able to integrate knowledge and handle the complexity of making judgments based on information that includes considerations on social and ethical responsibilities linked to the application of their knowledge and judgments. Furthermore, they should know how to apply the relevant mathematical and statistical methods to model, design, implement, operate and maintain applications.

In the case of the master's program Information and Research in Informatics, the graduates should be able to apply scientific methods to analyze phenomena and systems in Computer Science and should acquire competences in the conception, design and implementation of innovative and original solutions. They should have the capacity for mathematical modelling, calculation and experimental designing, particularly in research and innovation in all areas of Computer Science. Moreover, they shall know how to apply innovative solutions and make progress in the knowledge to exploit new paradigms of computing. In addition to these general technical competences, specific competences are defined for each specialization.

Next to the professional skills, the students of all three programs are supposed to acquire interdisciplinary, personal and social competences. These include awareness of legal aspects of informatics and its effects on society as well as ethical questions and security problems connected with the application of information processing systems. Furthermore, students shall acquire practical skills and be able to apply the theoretical knowledge during the practical sessions. Other social competences include effective communication, English language skills, the capacity to work in teams. In particular in the two master's programs, students shall also acquire project management and leadership skills as well as the ability of conducting independent research.

The peers conclude that the bachelor's program adequately reflects level 6 of the European Qualification Framework (EQF) while both master's programs are adequate to EQF level 7.

The program objectives and learning outcomes of all three programs are consistent with the ASIIN Subject-Specific Criteria of the Technical Committee Informatics/Computer Science and therefore correspond with the Euro-Inf® standards. They aim at the acquisition of specific competences and are described in a brief and concise way. They are well-anchored, binding and easily accessible to all stakeholders.

Criterion 1.2 Name of the degree program

Evidence:

- Self-assessment report
- Website per program

Preliminary assessment and analysis of the peers:
The original names of the study programs are *Grau en Enginyeria Informàtica* for the bachelor's program, *Màster en Enginyeria Informàtica* for the master's program Informatics Engineering and *Master in Innovation and Research in Informatics*. The *Master in Innovation and Research in Informatics* is implemented entirely in English. The expert panel considers the names of the study programs to be adequately reflecting the respective aims, learning outcomes, and curricula as well as the language of instruction.

Criterion 1.3 Curriculum

Evidence:

- Website per program, where the module descriptions are published
- Competence-subject matrices
- Self-assessment report
- Discussions during the audit

Preliminary assessment and analysis of the peers:
The curricula of all study programs under consideration are reviewed by the panel in order to identify whether the described program objectives and learning outcomes can be achieved by the available modules. Course descriptions as well as overviews and competence-subject matrices matching the general learning objectives and the module contents were provided for a thorough analysis. In the self-assessment report, the university gives a detailed overview of how the competences acquired with the presented curricula match the individual Euro-Inf learning outcomes. For all three programs, the university has incorporated an automatic checking mechanism in the subject syllabus editor in order to guarantee that all competences and objectives have been included in any of the programmed

activities. This helps to double check the accomplishment of the competences of the curriculum.

The bachelor's degree program lasts four years and thus consists of eight semesters, during which the students acquire 240 ECTS in total which are divided among compulsory credits (132 ECTS), specialization credits (48 ECTS, one specialization to be chosen), optional credits (42 ECTS) and the bachelor's thesis (18 ECTS). The first four semesters serve as an introduction period during which the students acquire the scientific foundations as well as core topics of the discipline of computer science in order to get a fundamental understanding of central concepts and methods of the discipline. At the end of the fourth semester, the students choose one (out of five) specializations. The specializations offered are: Computer engineering, Computing, Information systems, Information technology, and Software engineering.

The master's program Informatics Engineering consists of three semesters during which the students acquire 90 ECTS in total. The program is divided into the two module groups *Direction and Management* (comprises 12 ECTS) and *Information Technologies* (comprises 48 ECTS). The curriculum imparts knowledge and hands-on experience in a wide range of information technology fields: from cloud computing to security, from computer graphics to information systems, with a focus on IT management and leadership. At the end of their studies, the students have to write their final thesis, which comprises 30 ECTS.

The master's program Innovation and Research in Informatics consists of four semesters during which the students acquire 120 ECTS in total. The curriculum is designed to provide a solid background in different aspects of research in informatics, while preparing the students to become experts in any of the fields of specialization offered. Those specializations are: Advanced Computing, Computer Graphics and Virtual Reality, Computer Networks & Distributed Systems, Data Science, and High Performance Computing.

All in all, the peers have a very good impression of the curricula of all three programs. By thoroughly analyzing the module descriptions and following the discussions during the online visit, the peers state that the three curricula are coherent and well structured. The individual courses/modules build upon and complement each other in a meaningful, appropriate way. With regard to the bachelor's program, the peers note that the curriculum does not contain any compulsory modules on theoretical computer science or IT security, but at the same time includes a compulsory module on physics, what they consider outdated. The peers learn that the curricula are structured based on governmental regulations and that these do not require mandatory courses on theoretical informatics or IT security for all graduates of the program. Instead, according to the regulations, theoretical computer science is compulsory only for graduates of the specialization *Computing*, while IT

security is only compulsory for those who choose the specialization *Information Technologies*. To enable all students to take at least a certain amount of theoretical computer science, the faculty has included a few selected aspects of theoretical informatics in the compulsory module "Data structures and algorithms". Although the peers acknowledge that the basics aspects of theoretical computer science are taught to all students, independent of the specialization, they emphasize the importance of having a solid foundation of theoretical aspects of computer science. Moreover, they stress that the ASIIN subject-specific criteria as well as the Euro-Inf standards clearly require all graduates from undergraduate computer science degrees to gain fundamental knowledge and competencies in theoretical informatics, as it is considered one of the core subjects of the discipline. According to the peers, having a course on models of computation and a course on logic is today standard in every computer science curriculum. Regarding IT security, the peers believe this to be a cutting-edge topic that will become even more relevant in the future and should therefore be integrated in any computer science program, also as it is required by many employers. The peers therefore urge the faculty to further strengthen the contents of theoretical informatics and IT security, ideally by introducing independent modules that explicitly cover these topics.

During the discussion with the industry representatives, the peers learn that the future employers are generally very satisfied with the graduates of the programs, in particular because they have a broad technical knowledge and are able to apply this knowledge in practice. Moreover, they stress that the graduates have excellent research skills. However, over the last years the industry representatives have been witnessing that a considerable number of graduates lacks interdisciplinary competences, in particular project management and English language skills. With regard to project management, the industry representatives particularly miss the knowledge and application of agile methods. These statements do not surprise the peers, as it has become a general issue that graduates have solid technical competences but often lack fundamental non-technical, social and personal skills. When looking at the curricula, the peers get the impression that the contents on (project) management are indeed rather limited and therefore recommend strengthening them in the curricula, for example also by introducing more group projects. Moreover, the peers fully agree with the industry representatives regarding the great need for excellent English skills and stress that this is particularly important in the IT sector, where English has become the lingua franca. Since the graduates will most likely be involved in many international projects in their later professional life, the peers highly recommend introducing more English-taught modules so that the students get used to working in English at an early stage.

Criterion 1.4 Admission requirements

Evidence:

- Faculty website that gives separate information on admission to bachelor's and master's degrees
- Self-assessment report
- Discussions during the online audit

Preliminary assessment and analysis of the peers:
The admission requirements are published on the website and thereby accessible for all potential students or other stakeholders. The panel acknowledged that set rules and regulations formally stipulate the admission requirements and process.

Admission to the bachelor's program follows a common procedure for all bachelor's programs at public universities. The Catalan government establishes an official list that is based on the general law of supply and demand. Candidates are ranked according to the (final) grades obtained at high school and in the university entrance exams.

For the two master's programs specific admission criteria are defined and presented on the program websites. Both program require an undergraduate degree in Informatics Engineering or Data Science and Engineering. Students with degrees in Telecommunications, Electronics, Industrial Engineering or similar are assigned extra preparatory courses before they can begin the master's program if their background is deemed unsatisfactory by the board of examiners. The admission is denied if more than 30 ECTS are necessary. In terms of language requirements, the peers understood that an English B2 level certificate (CEFR) is required for the master's program Innovation and Research in Informatics and a Spanish B2 level certificate (CEFR) for the master's program Informatics Engineering. Overall, the peers agree that the admission requirements ensure that the master's programs can be implemented without any delays or without decreasing the overall level due to extremely different backgrounds. However, they note that the website does not provide precise information on what the preparatory courses look like exactly. Although the program coordinators explain that the preparatory courses are assigned individually by the admission commission, the peers would appreciate more detailed information about the preparatory courses being available on the website, for example by listing possible courses that need to be taken by applicants with certain backgrounds.

In summary, the auditors find the terms of admission to be binding and transparent. They confirm that the admission requirements support the students in achieving the intended learning outcomes.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 1:

The peers consider criterion 1 to be completely fulfilled.

2. The degree program: structures, methods and implementation

Criterion 2.1 Structure and modules

Evidence:

- Website per program
- Self-assessment report
- Discussions during the audit

Preliminary assessment and analysis of the peers:

After analyzing the module descriptions and the curricula, the peers confirm that all degree programs under review are divided into modules and that each module is a sum of coherent teaching and learning units. The peers appreciate the clearly presented structure of the degree programs on their websites and consider the layout of the programs and the individual modules useful in order to achieve the overall intended learning outcomes. All three programs include specialization options with a fixed curriculum as described above and various elective courses, which allow students to develop an individual profile and to arrange their syllabus accordingly. The students are satisfied with the range of specializations and electives; however, they emphasize that access to the electives should be improved and simplified, as it is currently limited.

As a general rule for Bachelor degrees at the university, all first year modules (initial stage) have to be passed within two years. Additionally, several third semester courses have first and second semester courses as prerequisites. The peers considered this practice as adequate in order to ensure that students have the required fundamental knowledge to follow advanced courses.

All three programs can be studied in part-time as well. Bachelor part-time students may enroll in a maximum of 36 ECTS credits per year (18 ECTS credits per semester) for the duration of the degree course. Accordingly, the duration of the Bachelor degree program extends to 8 years in total. However, after the initial phase (60 ECTS passed), the university cannot distinguish anymore between part- and full-time students as the students pay per

credit and therefore, decide on an individual basis for how many courses they enroll each semester irrespective if they are full- or part-time students.

Several coordination mechanisms have been devised for the Bachelor Degree in Informatics Engineering. The academic staff responsible for the subjects constitutes the first level of coordination mechanisms, and this is usually a senior or expert professor. The common compulsory modules are divided into five areas, each of which has a coordinator. Each specialization has also been appointed a coordinator. All coordinators meet at least once a year with both Heads of Studies. The ultimate responsibility for the coordination of studies lies with the Head of Studies. All master's programs have the same coordination structure. The coordination is implemented in three different levels: at the program year level, at the area level (i.e. group of courses in the same area) and global. The area coordinator is responsible for distributing the learning objectives and competences among the courses in the area. The global coordination ensures the coordination among areas and semesters. This global coordination is one of the tasks of the Master's Academic Committee, and there is one for each master's program. In addition, generic competences or professional skills deserve specific coordination due to their transverse nature. The panel welcomes these coordination mechanisms, as they ensure that the modules are consistent within themselves, are matched against each other, build upon each other and consequently, viewed all together to support the intended academic level.

The three programs prepare the students well for their later professional life by different means: Generally, the projects for the final thesis are usually directly related to practical issues of professional life and can be undertaken at a university research group, a company or a foreign university. There are voluntary internships and very good relations to local and international enterprises. The faculty has established and maintained relationships with many future employers who offer paid internships, fellowships and trainee programs. Both, employers and students seemed very satisfied with the offered internships. Within all three programs several projects and lab works are included in the curricula.

The school has built up a very good network of international cooperation so students are given the opportunity to do a double degree, study abroad term, summer school or international internship in order to broaden their horizon and to define a more specific focus of study. The peers regret that the demand for taking such international opportunities remains still comparatively low, although the faculty is actively encouraging them and offering attractive target countries. Although language issues do not seem to be the main reason for so few students being interested in an international exchange, the peers are confident that introducing more English modules (see criterion 1.3) could also increase the demand for international activities. The recognition of externally acquired competences is regulated at university, not at school level. It is stipulated in the Academic Rules of the university,

published on the website. The peers consider these to be in line with the expectations of the Lisbon Convention.

Criterion 2.2 Work load and credits

Evidence:

- Website per program, where the module descriptions are published
- Self-assessment report
- Discussions during the online visit

Preliminary assessment and analysis of the peers:
The allocation of ECTS credits to lectures, practical sessions and self-study periods of the modules appear plausible. The workload documentation clearly states the workload distribution between lectures and independent student work and is made transparent in the module descriptions. The defined practice of continuous assessment further described in the criterion 3 avoids structure-related peaks in the workload and enables students to complete the degree without exceeding the regular course duration. The student workload is evaluated through surveys at the end of each semester. The faculty asks undergraduate students to participate in a survey on the number of hours dedicated to a subject, correlating this information with the final grade of the students in the subject. This serves as a feedback for the lectures that shall help detect any anomalous situation with regard to the activities. Although the faculty considers this tool to be very useful, student participation is rather low. The faculty is eager to establish new incentives to reach a much higher participation of the undergraduate students.

During the previous accreditation procedure that was implemented in 2016, the peer panel had noted very high dropout rates in the bachelor's program (54.6 %), in particular after the first year of studies. In order to counter these rates, the faculty established a tutorial action plan, which includes three different programs: peer mentoring, peer academic mentoring (both of them particularly addressed to first year undergraduate students), and tutorship. Additional actions are organized in order to give special support and information about degree specializations, final degree projects and mobility programs. As a consequence, the dropout rate in the bachelor's program has significantly decreased since the launch of these mentoring programs (19.7% in 16/17 and 21.7% in 17/18, after the first year; 42.1% in 17/18, 35.9% in 18/19 and 30.6% in 19/20, within the whole degree). The peers expressly appreciate the measures that were taken and are very glad to see that they have an impact on the numbers in practice.

The peers confirm that the workload in hours is indicated in the module descriptions and the distinction between classroom work and self-studies is made transparent and is in line with the credits awarded. During the discussions with the students, the peers learn that they deem the workload as well as the number of exams to be adequate and that they still find time to develop their individual interests and skills outside of the university by working or taking extracurricular classes. The peers believe the overall workload to be manageable, especially since nearly all students graduate on time.

Criterion 2.3 Teaching methodology

Evidence:

- Website per program, where the module descriptions are published
- Self-assessment report
- Discussions during the online visit

Preliminary assessment and analysis of the peers:
The faculty has implemented various teaching and learning methods which reflect the good practices of teaching in informatics engineering programs by involving theory classes, lab work, teamwork-projects, video lectures, presentations, reading, analysis and problem solving tasks in the every day's teaching activities. In addition an online teaching platform (Atenea & Racó) with specific teaching support tools is implemented allowing students to receive online feedback on their programming codes. Online teaching has been largely extended during the COVID 19 pandemic. Projects are conducted in several modules in all three programs. These do not only focus on the practical application of the theoretical knowledge but also require the students to do research, both independently and in group. The labs, which are well equipped (see also criterion 5.3), allow for adequate and state-of-the-art teaching. The students are generally satisfied with the teaching as such, but mention that most teachers stick to traditional teaching methods, which are not focused on the student (lectures, seminar). The students would much appreciate having more research projects and less traditional lectures.

Overall, the panel considered the teaching methods used for implementing the didactical concept as appropriate and the ratio of contact hours to self-study time seems to support the achievement of the intended learning objectives.

Criterion 2.4 Support and assistance

Evidence:

- Self-assessment report
- Discussions during the online visit

Preliminary assessment and analysis of the peers:
The relation between lecturers and students is considered to be one of the strong points of the programs. The peers get the impression that close relations exist between students and teachers. They also positively acknowledge that teaching staff and program coordinators were very accessible for students' requests. In addition, the faculty has developed a new mentoring concept in order to offer students intense support, in particular first-year students. The concept comprises the peer mentoring and the peer academic mentoring.

During the peer mentoring program, senior undergraduate/master's students welcome and accompany first year students during seven one-hour sessions during their first semester. The program started in September 2016 and is intended to ease integration into a new environment, to encourage the building of positive relationships and to give some tips in order to develop healthy and profitable study habits. The peer academic mentoring is intended to provide support that is directly related with the studies as such. The program began in September 2017 and is addressed to bachelor's students. Within the program, senior students deliver support classes (tutorials) to first year students free of charge. A senior trainer acts as the coordinator of the program. They are responsible for the initial call and selection of trainers, sessions scheduling and admission process, under the supervision of the vice-dean Head of Academic Studies for Initial Phase students and the vice-dean for Students. A minimum of 10 sessions per subject and semester are scheduled, with every session lasting two hours. As has been mentioned above (criterion 2.2), the dropout rate of the bachelor's program has significantly decreased since the launch of these mentoring programs.

General advice and guidance are covered by the UPC Office for Equal Opportunities, the International Relations Office and the Career Center. The wide range of support and service initiatives taken by the FIB positively influences the study success of the students.

The employability of the school's graduates is very high, also due to a variety of networking activities organized by the school itself. Employers offer paid internships to senior students and both employers and graduates demonstrate a high level of satisfaction with the support provided by the teaching staff.

The peers welcome that all information is published on the program websites. There are enough resources available to provide individual assistance, advice, and support for all students. The support systems help the students to achieve the intended learning outcomes to complete their studies successfully and without delay.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 2:

The peers consider criterion 2 to be completely fulfilled.

3. Exams: System, concept and organisation

Criterion 3 Exams: System, concept and organisation

Evidence:

- Module descriptions per program
- Academic regulations
- Sample exams, projects, and final theses
- Self-assessment report
- Discussions during the online audit

Preliminary assessment and analysis of the peers:

The examination practice in place is clearly and transparently described in the syllabi, including the examination forms, the weighting of the examination parts as well as the calculation of the final grade. The evaluation methods include exams, assignments, lab sessions, projects, and presentations and are in their concept and variety fully satisfactory. Oral examinations do occur in the form of presentations (in project works, for instance) and as part of the final theses. All three programs include a final thesis/project which ensures that students work on a set task independently.

Each course-content in the reviewed study programs is reflected in exams, which take place in the form of continuous assessment, as they are divided into subject-specific assignments, mid-term examinations, and final examinations. The panel as well as the students welcome this kind of learning assessment as it allows a close monitoring of the students' learning progress and encourages students' motivation throughout the semester. By way of helping students to consciously assess their actual state of knowledge, the assessment procedure at the same time contributes to an adequate exam preparation.

The organization of the exams guarantees examinations that avoid delay to students' progressions. The relevant rules for examination and evaluation criteria are transparently put into a legal framework, as both students and lecturers confirm in the audit discussions. The date and time of the exams are announced in due time in the Academic calendar of the

university. Except for the first year modules, no re-examinations are offered to the students. However, all mandatory modules are offered every semester, so students may register again in the next semester. The peers confirm that rules have been defined for disability compensation measures, illness and other mitigating circumstances.

During and after the visit, the panel analyzed a number of theses and exam papers and gained the impression that, in general, the academic level was adequate.

Shortly before the online visit, the peers were provided with a selection of exams and final projects to check. They confirm that these represent an adequate level of knowledge as required by the EQF level 6 for the bachelor's program and EQF level 7 for the two master's programs. In conclusion, the peers note that all relevant examination regulations are in place and well communicated in a transparent way. The forms of exams are oriented toward the envisaged learning outcomes of the respective courses, and the workload is distributed in an acceptable way.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 3:

The peers consider criterion 3 to be completely fulfilled.

4. Resources

Criterion 4.1 Staff

Evidence:

- Staff handbook
- Self-assessment report
- Discussions during the online visit

Preliminary assessment and analysis of the peers:

The teaching staff at FIB is distributed within eight institutes according to the disciplines/areas of teaching-scientific domain. The faculty's staff members have different academic positions. There are professors and lecturers. Professors with permanent positions in Spain can be employed by the national Spanish Government (civil servants) or by the regional government. Their positions distinguish between full professors, associate professors, and assistant professors. Lecturers are professionals who work outside the university and are experts in a certain field. They are hired on a temporary and part-time basis to contribute with their knowledge and professional experience to the university.

The decrease in university funding has led to a decreasing number of permanent teaching staff, being replaced by non-permanent staff (mainly lecturers) who combine university activity with other jobs. This policy means there is a lack of generational change of permanent teaching staff. Likewise, in this group the percentage of doctors and people who carry out research activities has been reduced. Lecturers teach professional-oriented subjects. Thus, the faculty combines the academic approach offered by permanent academic staff with a professional perspective provided by non-permanent academic staff. In the academic year 2019-2020, the faculty accommodated 240 academic staff members, out of which 169 hold a doctoral degree (27 were full professors). The number of non-permanent staff members amounts to 65, out of which 23 hold a doctoral degree.

By thoroughly examining the provided CVs of the staff members involved in the programs, the peers confirm that the composition, scientific orientation and qualification of the teaching staff are suitable for successfully implementing and sustaining the degree programs. The auditors are impressed by the excellent and open-minded atmosphere among the students and the staff members. Both confirm that in case of questions or problems, there is always an academic advisor available to solve the issues together with the student. The academic staff is supported by the administrative and technical employees at department, faculty, and university level.

Criterion 4.2 Staff development

Evidence:

- Self-assessment report
- Discussions during the online visit

Preliminary assessment and analysis of the peers:
The ICE (in Catalan, Institut de Ciències de l'Educació) of the Polytechnic University of Catalonia offers training courses for teaching staff who wish to further develop their professional and teaching skills. FIB actively supports and encourages their teaching staff to attend the training offers. The school also has academic staff participating in research and projects on innovation in teaching methods, as well as the use of modern educational technologies in accordance with the EHEA framework. The teaching staff confirms that the offered trainings are useful and well received.

The university has implemented a specific program for sabbaticals that provides access to a paid leave for a maximum duration of 12 months. The aim of this action is to promote the research activity of the selected persons. Due to budget restrictions, the program offers a limited number of sabbatical leaves. During the discussion with the teaching staff, the peers learn that the number of those taking a sabbatical leave is rather low, as funding is very

limited and the application for funding very time-consuming. The staff members identify the lack of financial support for sabbaticals (and other research activities) to be one of the biggest weaknesses of the university. On the other hand, the peers get the impression that the teaching team is dedicated to research and many of them would be much more likely to take a research semester if funding allowed so. The peers therefore recommend improving the funding opportunities (or establishing new opportunities) in order to be able to allow regular sabbatical leaves, which the peer panel consider to be of great importance.

All in all, the panel considered the measures taken for staff development as adequate and beneficial for the implementation of the programs.

Criterion 4.3 Funds and equipment

Evidence:

- Self-assessment report
- Video and photo material
- Discussions during the online visit

Preliminary assessment and analysis of the peers:
UPC is a public university and is funded by the national and regional government. The university budget is managed at two levels: a centralized budget and a delegated budget for each faculty and department. The central administration manages the centralized budget, which includes the staff salaries, major investments and financial operations for the whole university. The faculties are provided with a delegated budget for some current expenses such as teaching and lab materials. They are also allowed to keep a share of particular incomes, such as those from educational cooperation agreements or classroom rental.

Spanish universities have been facing economic restrictions since the global economic crisis of 2008. Compared to the EU average (which is 1.27 %), Catalonia devotes only 0.715 % of its GDP to universities. The FIB community has coped with this situation mainly through collaborations with the industry. The peers get the impression that the financial resources are overall sufficient in order to implement the study programs successfully, although it cannot be denied that the financial situation is not as stable as that of other western European universities.

In the self-assessment report, the faculty gives a detailed overview of the available learning spaces, the library, online platforms and service, and the labs used for the three programs. Due to the ongoing COVID-19 pandemic, it is not possible for the peer panel to travel to Catalonia and visit UPC/FIB in person. Therefore, the faculty has provided the peers with video and photo material showing its campus with its most relevant research and teaching

facilities as well as laboratories available for the three study program. The peers confirm that the resources for teaching and learning, in particular classrooms, computer rooms, laboratories and library are sufficiently well maintained and adhere to the international standard. The premises are spacious and offer ample opportunities for the professional and individual development of students and teachers. The students confirm that they are provided with all relevant software and are given easy access to all necessary rooms and equipment.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 4:

The peers consider criterion 4 to be completely fulfilled.

5. Transparency and documentation

Evidence:

- Module descriptions per program

Preliminary assessment and analysis of the peers:
The module descriptions are published on each program's website in English, Catalan and Spanish, so that students and stakeholders can access them at any time.

After studying the module descriptions, the peers confirm that they include all necessary information about the persons responsible for each module, the teaching methods and work load, the credit points awarded, the intended learning outcomes, the applicability, the admission and examination requirements, and the forms of assessment as well as details explaining how the final grade is calculated.

Criterion 5.2 Diploma and Diploma Supplement

Evidence:

- Sample graduation certificate per program
- Sample diploma supplement per program
- Sample transcript of records per program

Preliminary assessment and analysis of the peers:
With the successful completion of their studies, the students receive a graduation certificate, a transcript of records, and a diploma supplement. The diploma supplements are trilingual (Catalan, Spanish and English) and contain all relevant information on the student's

qualifications profile and individual performance as well as the classification of the degree program with regard to its applicable education system.

Criterion 5.3 Relevant rules

Evidence:

- Website per program
- Academic regulation per program
- Admission requirements
- Discussions during the online audit

Preliminary assessment and analysis of the peers:
The peers confirm that the rights and duties of both the university and the students are clearly defined and binding. All rules and regulations are published on the university's website in Catalan, Spanish and English and hence are available to all relevant stakeholders.

In addition, students receive all relevant course materials in the language of the degree program at the beginning of each semester.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 5:

The peers consider criterion 5 to be completely fulfilled.

6. Quality management: quality assessment and development

Criterion 6 Quality management: quality assessment and development

Evidence:

- Faculty website
- Monitoring and verification reports
- Self-assessment report
- Discussions during the online visit

Preliminary assessment and analysis of the peers:

From the self-assessment , it becomes obvious to the peers that UPC and FIB have a multi-faceted quality management system that aims at a constant development and improvement of the procedures, the programs and all individual stakeholders. The university applies both external and internal quality assurance. The external quality assurance is implemented by the Catalan accreditation agency AQU and international accreditation, while UPC's internal quality assurance is managed mainly on faculty level.

Two evaluation methods for the Bachelor degrees modules are implemented. Students complete the voluntary online questionnaire at the end of each module; additionally in every course, one student is appointed to write two reports on the course quality, the first at the middle of the semester and second at the end of the semester. The results of the online surveys are announced at the end of the semester and are communicated to the students through a course representative. In most cases, they are also discussed in class, but this could be further improved, as it depends on the respective teacher in how much detail the discussion of results takes place in practice. Master's students give formal feedback by completing online questionnaires. The discussion with lecturers, program coordinators and students also showed that the results of regular module evaluations are effectively analyzed in bimonthly committee meetings and steps for improvements were taken. Equally, students and employers are represented in the Quality Committee, which specifically ensures continuous enhancement of program quality through the analysis of objective data. The committees responsible for the design of the degree program took into account stakeholders' needs by consulting graduates, employers, informatics professional association and technology sponsors. Regularly employer surveys ask for the perceptions of the employability and skills of recent graduates. The peers positively noted that the information gained is made transparent to all stakeholders.

In addition to the formal and systematic quality assurance mechanisms, the panel commended that the close relation between students and teachers contributed to an atmosphere of confidence.

Final assessment of the peers after the comment of the Higher Education Institution regarding criterion 6:

The peers consider criterion 6 to be completely fulfilled.

D Additional Documents

No additional documents needed.

E Comment of the Higher Education Institution

F Summary: Peer recommendations (07.09.2021)

The peers summarise their analysis and final assessment for the award of the seals as follows:

Degree Programme	ASIIN Seal	Maximum duration of accreditation	Subject-specific label	Maximum duration of accreditation
Ba Informatics Engineering	Without requirements	30.09.2028	Euro-Inf®	30.09.2028
Ma Informatics Engineering	Without requirements	30.09.2028	Euro-Inf®	30.09.2028
Ma Innovation and Research in Informatics	Without requirements	30.09.2028	Euro-Inf®	30.09.2028

Recommendations

For the bachelor's program

E 1. (ASIIN 1.3) It is strongly recommended to strengthen aspects of theoretical informatics and IT security within the curriculum.

For the master's programs

E 2. (ASIIN 1.3) It is recommended to specify the admission requirements on the website by providing precise information on possible preparatory courses.

For all programs

E 3. (ASIIN 1.3) It is recommended to strengthen interdisciplinary competences, in particular with regard to project management and English language skills.

E 4. (ASIIN 4.2) It is recommended to improve funding opportunities for sabbaticals.

G Comment of the Technical Committee 04 – Informatics/Computer Science (10.09.2021)

Assessment and analysis for the award of the ASIIN seal:

The Technical Committee discusses the procedure and follows the decision of the peers without any changes.

Assessment and analysis for the award of the Euro-Inf® Label:

The Technical Committee deems that the intended learning outcomes of the degree programmes do comply with the Subject-Specific Criteria of the Technical Committee 04 – Informatics/Computer Science.

The Technical Committee 04 – Informatics/Computer Science recommends the award of the seals as follows:

Degree Programme	**ASIIN Seal**	**Maximum duration of accreditation**	**Subject-specific label**	**Maximum duration of accreditation**
Ba Informatics Engineering	Without requirements	30.09.2028	Euro-Inf®	30.09.2028
Ma Informatics Engineering	Without requirements	30.09.2028	Euro-Inf®	30.09.2028
Ma Innovation and Research in Informatics	Without requirements	30.09.2028	Euro-Inf®	30.09.2028

H Decision of the Accreditation Commission (17.09.2021)

Assessment and analysis for the award of the ASIIN seal:

The Accreditation Commission discusses the procedure and follows the decision of the peers and the Technical Committees without any changes.

Assessment and analysis for the award of the Euro-Inf® Label:

The Accreditation Commission deems that the intended learning outcomes of the degree programmes do comply with the Subject-Specific Criteria of the Technical Committee 04 – Informatics/Computer Science.

The Accreditation Commission decides to award the following seals:

Degree Programme	ASIIN Seal	Maximum duration of accreditation	Subject-specific label	Maximum duration of accreditation
Ba Informatics Engineering	Without requirements	30.09.2028	Euro-Inf®	30.09.2028
Ma Informatics Engineering	Without requirements	30.09.2028	Euro-Inf®	30.09.2028
Ma Innovation and Research in Informatics	Without requirements	30.09.2028	Euro-Inf®	30.09.2028

Recommendations

For the bachelor's program

E 1. (ASIIN 1.3) It is strongly recommended to strengthen aspects of theoretical informatics and IT security within the curriculum.

For the master's programs

E 2. (ASIIN 1.3) It is recommended to specify the admission requirements on the website by providing precise information on possible preparatory courses.

For all programs

E 3. (ASIIN 1.3) It is recommended to strengthen interdisciplinary competences, in particular with regard to project management and English language skills.

E 4. (ASIIN 4.2) It is recommended to improve funding opportunities for sabbaticals.

Appendix: Program Learning Outcomes and Curricula

An extensive description of the **objectives** and **learning outcomes** of the Bachelor degree program Informatics Engineering can be found on the program website:

https://www.fib.upc.edu/en/studies/bachelors-degrees/bachelor-degree-informatics-engineering/curriculum/competences

The following **curriculum** is presented:

Compulsory

Q1:September-January **Q2**:February-June

Acronym	Complete name	Open 21-22	Languages
F	Physics	Q1, Q2	Catalan
FM	Fundamentals of Mathematics	Q1, Q2	Catalan, Spanish
IC	Introduction to Computers	Q1, Q2	Catalan
PRO1	Programming I	Q1, Q2	Catalan, Spanish, English (Q1)
EC	Computer Organization	Q1, Q2	Catalan
M1	Mathematics I	Q1, Q2	Catalan, Spanish, English (Q1)
M2	Mathematics II	Q1, Q2	Catalan, Spanish, English
PRO2	Programming II	Q1, Q2	Catalan, Spanish
BD	Databases	Q1, Q2	Catalan
CI	Computer Interfacing	Q1, Q2	Catalan, Spanish
EDA	Data Structures and Algorithmics	Q1, Q2	Catalan, Spanish, English (Q1)
PE	Probability and Statistics	Q1, Q2	Catalan, Spanish
SO	Operating Systems	Q1, Q2	Catalan, Spanish, English (Q1)
AC	Computer Architecture	Q1, Q2	Catalan, Spanish
EEE	Business and Economic Environment	Q1, Q2	Catalan, Spanish
IDI	Interaction and Interface Design	Q1, Q2	Catalan, Spanish
IES	Introduction to Software Engineering	Q1, Q2	Catalan
XC	Computer Networks	Q1, Q2	Catalan, English (Q1)
PAR	Parallelism	Q1, Q2	Catalan, Spanish, English (Q1)
PROP	Programming Projects	Q1, Q2	Catalan, Spanish

Specialization

Computing

Specialization compulsory subjects

Acronym	Complete name	Open 21-22	Languages
A	Algorithmics	Q1, Q2	Catalan, Spanish
G	Graphics	Q1, Q2	Catalan, Spanish
IA	Artificial Intelligence	Q1, Q2	Catalan, Spanish
LI	Logics in Information Technology	Q1, Q2	Catalan, Spanish
LP	Programming Languages	Q1, Q2	Catalan
TC	Theory of Computation	Q1, Q2	Catalan, Spanish

Specialization complementary subjects

Acronym	Complete name	Open 21-22	Languages
AA	Advanced Algorithmics	Q2	Catalan
APA	Machine Learning	Q1	Catalan
CAIM	Massive Information Search and Analysis	Q1	Catalan, Spanish
CL	Compilers	Q2	Catalan
CN	Numerical Computation	Q2	Catalan
IO	Operations Research	Q1	Catalan, Spanish
SID	Distributed Intelligent Systems	Q2	Spanish

Computer Engineering

Specialization compulsory subjects

Acronym	Complete name	Open 21-22	Languages
AC2	Computer Architecture II	Q1, Q2	Catalan, Spanish
DSBM	Design of Microcomputer-Based Systems	Q1, Q2	Catalan
MP	Multiprocessors	Q1, Q2	Spanish
PEC	Computer Engineering Project	Q1, Q2	Catalan
SO2	Operating Systems II	Q1, Q2	Catalan, Spanish
XC2	Computer Networks II	Q1, Q2	Spanish

Specialization complementary subjects

Acronym	Complete name	Open 21-22	Languages
CASO	Advanced Concepts On Operating Systems	Q2	Catalan, Spanish
CPD	Data Processing Centers	Q1, Q2	Catalan
PAP	Parallel Programming and Architectures	Q2	Catalan
PCA	Architecture-Aware Programming	Q2	Catalan, Spanish
PDS	Digital Signal Processing	Q1	Catalan
STR	Real-Time Systems	Q2	Catalan
VLSI	VLSI	Q1	Catalan

Software Engineering

Specialization compulsory subjects

Acronym	Complete name	Open 21-22	Languages
AS	Software Architecture	Q1, Q2	Catalan
ASW	Web Applications and Services	Q1, Q2	Catalan
DBD	Database Design	Q1, Q2	Catalan
ER	Requirements Engineering	Q1, Q2	Catalan, Spanish
GPS	Software Project Management	Q1, Q2	Catalan
PES	Software Engineering Project	Q1, Q2	Catalan

Specialization complementary subjects

Acronym	Complete name	Open 21-22	Languages
CAP	Advanced Programming Concepts	Q1	Catalan
CBDE	Concepts for Specialised Databases	Q1	Catalan
CSI	Information Systems Concepts	Q1, Q2	Catalan
ECSDI	Knowledge Engineering and Distributed Intelligent Systems	Q2	Catalan, Spanish
SIM	Simulation	Q1, Q2	Catalan
SOAD	Operating Systems for Distributed Applications	Q2	Catalan, Spanish

Information Systems

Specialization compulsory subjects

Acronym	Complete name	Open 21-22	Languages
ADEI	Data Analysis and Information Exploitation	Q1, Q2	Catalan
DSI	Information Systems Design	Q1, Q2	Catalan
ER	Requirements Engineering	Q1, Q2	Catalan, Spanish
NE	E-Business	Q1, Q2	Catalan, Spanish
PSI	Information Systems Project	Q1, Q2	Catalan
SIO	Information Systems for Organisations	Q1, Q2	Catalan

Specialization complementary subjects

Acronym	Complete name	Open 21-22	Languages
ABD	Database Administration	Q2	Catalan
CAIM	Massive Information Search and Analysis	Q1	Catalan, Spanish
EDO	Digital Strategy for Organisations	Q1	Spanish
IO	Operations Research	Q1	Catalan, Spanish
MI	Marketing On Internet	Q2	Catalan, Spanish
VPE	Viability of Business Projects	Q1	Catalan, Spanish

Information Technologies

Specialization compulsory subjects

Acronym	Complete name	Open 21-22	Languages
ASO	Operating Systems Administration	Q1, Q2	Catalan, Spanish
PI	Internet Protocols	Q1, Q2	Catalan, Spanish
PTI	Information Technology Project	Q1, Q2	Catalan, Spanish
SI	Computer Security	Q1, Q2	Catalan
SOA	Advanced Operating Systems	Q1, Q2	Catalan, Spanish
TXC	Computer Network Technology	Q1, Q2	Catalan, Spanish

Specialization complementary subjects

Acronym	Complete name	Open 21-22	Languages
AD	Distributed Applications	Q1	Spanish
CASO	Advanced Concepts On Operating Systems	Q2	Catalan, Spanish
CPD	Data Processing Centers	Q1, Q2	Catalan
IM	Wireless and Mobile Communications	Q2	Spanish
SDX	Distributed Network Systems	Q2	Catalan, Spanish
TCI	Information Transmission and Encoding	Q1	Catalan, Spanish

Elective

Acronym	Complete name	Open 21-22	Languages
APC	PC Architecture	Q1	Catalan, Spanish
APSS	Academic and Professional Speaking Skills	Q1, Q2	English
ASDP	Academic Skills for Developing a Project	Q1, Q2	English
ASMI	Social and Environmental Issues Od Information Technologies	Q1, Q2	Catalan
C	Cryptography	Q1	Spanish
CCQ	Quantum Computing and Cryptography	Q1, Q2	Catalan
CDI	Data and Image Compression	Q2	Catalan, Spanish
DCS	Curve and Surface Design	Q2	English
FDM	Physics of Memory Devices	Q2	Catalan
FOMAR	Physics of Realistic Modelling and Animation	Q2	English
GCS	Cybersecurity Management	Q1, Q2	English
GEOC	Computational Geometry	Q1	English
MD	Data Mining	Q1, Q2	English
PAE	Applied Engineering Project	Q1, Q2	Catalan, Spanish
ROB	Robotics	Q1, Q2	Catalan, Spanish
SLDS	Free Software and Social Development	Q1	Spanish
TGA	Graphic Cards and Accelerators	Q2	Spanish
VC	Computer Vision	Q1, Q2	Catalan
VJ	Videogames	Q1, Q2	Catalan, Spanish
WSE	Writing Skills for Engineering	Q1, Q2	English

An extensive description of the **objectives** and **learning outcomes** of the Master degree program Informatics Engineering can be found on the program website:

https://www.fib.upc.edu/en/studies/masters/master-informatics-engineering/curriculum/competences

The following **curriculum** is presented:

Compulsory

Q1:September-January **Q2**:February-June

Direction and Management Module

Acronym	Complete name	Open 21-22	Languages
PEGTI	Strategic Planning and IT Governance	Q1	Catalan, Spanish
VPEI	Viability of Innovative Business Projects	Q2	Catalan, Spanish

Information Technologies Module

Acronym	Complete name	Open 21-22	Languages
ACAP	High Performance Computer Architecture	Q1	Spanish
CSI	Computing and Intelligent Systems	Q1	Catalan, Spanish
DGSI	Development and Management of Information Systems	Q2	Catalan
ISDCM	Internet, Security and Multimedia Contents Distribution	Q2	Catalan, Spanish
SEU	Embedded and Ubiquous Systems	Q1	Catalan
SGI	Interactive Graphic Systems	Q1	Catalan

Elective

Direction and Management Module

Acronym	Complete name	Open 21-22	Languages
FPEI	Financing for Innovative Business Projects	Q2	Catalan, Spanish
IKPD	Incorporating The Know-How Into The Decision Process	Q1	Catalan
MEEGQ	EFQM and Quality Management	Q1	Catalan, Spanish
SECS	Sustainability, Economy and Social Commitment	Q1	Catalan, Spanish

Information Technologies Module

Acronym	Complete name	Open 21-22	Languages
ARCA	Realistic Animation of Articulated Bodies	Q1	Catalan, Spanish
CC	Cloud Computing	Q2	Catalan, Spanish
DSIGE	Software Development for Geographic Ans Spacial Information	Q2	Catalan, Spanish
IA	Interfaces and Accessibility		
ID	Digital Identity	Q1	Catalan, Spanish
IESI	Business Integration of Information Systems		
IT	Internet of Things	Q2	Spanish
JC	Computer Games	Q2	Catalan, Spanish
PTDMA	Programming of Cell Phones and Mobile Autonomous Devices	Q2	Catalan
TEB	Techniques and Tools for Bioinformatics	Q1	Catalan, Spanish
TIA	Informatic Technologies for Automation	Q2	Catalan, Spanish
TMD	Data Mining Techniques	Q1	Catalan

An extensive description of the **objectives** and **learning outcomes** of the Master degree program Innovation and Research in Informatics can be found on the program website:

https://www.fib.upc.edu/en/studies/masters/master-innovation-and-research-informatics/curriculum/competences

The following **curriculum** is presented:

Compulsory

Q1:September-January **Q2**:February-June

Acronym	Complete name	Open 21-22
AMMM	Algorithmic Methods for Mathematical Models	Q1, Q2
CPDS	Concurrence, Parallelism and Distributed Systems	Q1
SIRI	Seminars of Innovation and Research in Informatics	Q1, Q2
SMDE	Statistical Modelling and Design of Experiments	Q1, Q2
TMIRI	Techniques and Methodology of Innovation and Research in Informatics	Q1, Q2

Specialization

Advanced Computing

Specialization compulsory subjects

Acronym	Complete name	Open 21-22
ADS	Advanced Data Structures	Q2
CC	Computational Complexity	Q2
CPS	Combinatorial Problem Solving	Q2
RA	Randomized Algorithms	Q1

Specialization complementary subjects

Acronym	Complete name	Open 21-22
ADM	Algorithmics for Data Mining	Q2
AGT	Algorithmic Game Theory	Q2
AVLSI	Algorithms for VLSI	Q1
CSN	Complex and Social Networks	Q1

Computer Graphics and Virtual Reality

Specialization compulsory subjects

Acronym	Complete name	Open 21-22
A3DM	Advanced 3d Modeling	Q2
FRR	Fast Realistic Rendering	Q2
GTCG	Geometric Tools for Computer Graphics	Q1
VAR	Virtual and Augmented Reality	Q1

Specialization complementary subjects

Acronym	Complete name	Open 21-22
CA	Computer Animation	Q1
GPR	Geometricy Processing	Q1
SRGGE	Scalable Rendering for Graphics and Game Engines	Q2
SV	Scientific Visualization	Q1

Computer Networks and Distributed Systems

Specialization compulsory subjects

Acronym	Complete name	Open 21-22
CNANM	Computer Network Architectures and Network Management	Q1
SANS	Statistical Analysis of Networks and Systems	Q1
SNM	Stochastic Network Modelling	Q1
TOML	Topics On Optimization and Machine Learning	Q2

Specialization complementary subjects

Acronym	Complete name	Open 21-22
CCBDA	Cloud Computing and Big Data Analytics	Q2
DS	Decentralized Systems	Q2
FINE	Future Internet Networks	Q1
IAS	Internet Applications and Security	Q1

Data Science

Specialization compulsory subjects

Acronym	Complete name	Open 21-22
DAKD	Data Analysis and Knowledge Discovery	Q1
DW	Data Warehousing	Q1
ML	Machine Learning	Q2
MVA	Multivariate Analysis	Q1, Q2
OD	Open Data	

Specialization complementary subjects

Acronym	Complete name	Open 21-22
ADM	Algorithmics for Data Mining	Q2
AHLT	Advanced Human Languages Technologies	Q2
ASM	Advanced Statistical Modelling	Q1
BDM	Big Data Management	Q2
BSG	Bioinformatics and Statistical Genetics	Q1
IR	Information Retrieval	Q1
KMLMM	Kernel-Based Machine Learning and Multivariate Modelling	Q1
OTDM	Optimization Techniques for Data Mining	Q1
SNLP	Statistical Natural Language Processing	
SOBI	Service Oriented Business Intelligence	

High Performance Computing

Specialization compulsory subjects

Acronym	Complete name	Open 21-22
MA	Multiprocessors Architecture	Q2
OS	Operating Systems	Q1
PA	Processor Architecture	Q1

Specialization complementary subjects

Acronym	Complete name	Open 21-22
APA	Advanced Processor Architecture	Q2
CHPC	Compilers for High Performance Computers	Q1
NCD	Nanoelectronic Circuit Design	Q2
PD	Processor Design	Q1
PPTM	Parallel Programming Tools and Models	Q2
SA	Supercomputers Architecture	Q1
SCA	Supercomputing for Challenging Applications	Q1

Service Engineering

Specialization compulsory subjects

Acronym	Complete name	Open 21-22
EB	E-Business	
RES	Requirements Engineering for Services	
SM	Service Management	
SOA	Service Oriented Architecture	

Specialization complementary subjects

Acronym	Complete name	Open 21-22
ASE	Advanced Software Engineering	
BDM	Big Data Management	Q2
BIP	Business Intelligence Project	
DW	Data Warehousing	Q1
SEAIT	Social and Environmental Aspects of Information Technology	
SOBI	Service Oriented Business Intelligence	
VBP	Viability of Business Projects	Q2
WS	Web Services	

Elective

Acronym	Complete name	Open 21-22
ADSDB	Algorithms, Data Structures and Databases	Q1
DEWS	Design and Evaluation of Web-Based Systems	
I2P	Interdisciplinary Innovation Project	Q2
SIBIT	Service Innovation Based On Information Technologies	