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QUALITÄTSSICHERUNG DURCH
AKKREDITIERUNG VON
STUDIENGÄNGEN E.V.

FINAL REPORT

UNIVERSITY OF RWANDA

CLUSTER INTERNET OF THINGS

INTERNET OF THINGS (MASTER)
WITH SPECIALIZATIONS IN “EMBEDDED COMPUTING SYSTEMS” AND
“WIRELESS INTELLIGENT SENSOR NETWORKING”

INTERNET OF THINGS (PHD)
WITH SPECIALIZATIONS IN “EMBEDDED COMPUTING SYSTEMS” AND
“WIRELESS INTELLIGENT SENSOR NETWORKING”

December 2025



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DECISION OF THE AQAS STANDING COMMISSION ON THE STUDY PROGRAMMES

- “INTERNET OF THINGS” (MASTER) WITH SPECIALIZATIONS IN “EMBEDDED COMPUTING SYSTEMS” AND “WIRELESS INTELLIGENT SENSOR NETWORKING”
- “INTERNET OF THINGS” (PHD) WITH SPECIALIZATIONS IN “EMBEDDED COMPUTING SYSTEMS” AND “WIRELESS INTELLIGENT SENSOR NETWORKING”

OFFERED BY UNIVERSITY OF RWANDA, RWANDA

Based on the report of the expert panel and the discussions of the AQAS Standing Commission in its 27th meeting on 1 December 2025 the AQAS Standing Commission decides:

1. The study programmes “**Internet of Things**” (Master) with specializations in “Embedded Computing Systems” and “Wireless Intelligent Sensor Networking” and “**Internet of Things**” (PhD) with specializations in “Embedded Computing Systems” and “Wireless Intelligent Sensor Networking” offered by **University of Rwanda, Rwanda** are accredited according to the AQAS Criteria for Programme Accreditation (Bachelor/Master) and the AQAS Criteria for Doctoral Programme Accreditation (PhD).

The accreditations are conditional.

The study programmes essentially comply with the requirements defined by the criteria and thus the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) and the European Qualifications Framework (EQF) in their current version. The required adjustments can be implemented within a time period of twelve months.

2. The conditions have to be fulfilled. The fulfilment of the conditions has to be documented and reported to AQAS no later than **31 December 2026**. The confirmation of the conditions might include a physical site visit within the time period of twelve months.
3. The accreditation is given for the period of **six years** and is valid until **31 December 2031**, provided that the conditions listed below are fully met. Otherwise, the accreditation may be withdrawn.

Conditions:

1. All documents that show the level of publications as well as the number of papers need to be updated.
2. The university must demonstrate how the information regarding the supervision hours is communicated transparently to the students.

The following **recommendations** are given for further improvement of the programmes:

1. Several learning outcomes which are generic and overlapping, should further distinguished and better tailored to the very specific courses.
2. The inter-module application of different tools should be specified and harmonised for all courses in the Masters’ curriculum.
3. Beyond funding acquisition, further career-relevant skills and topics should be covered by the university.

With regard to the reasons for this decision the Standing Commission refers to the attached experts’ report.

EXPERTS' REPORT

ON THE STUDY PROGRAMMES

- “INTERNET OF THINGS” (MASTER) (WITH SPECIALISATION IN “EMBEDDED COMPUTING SYSTEMS” AND “WIRELESS INTELLIGENT SENSOR NETWORKING”)
- “INTERNET OF THINGS” (PHD) (WITH SPECIALISATION IN “EMBEDDED COMPUTING SYSTEMS” AND “WIRELESS INTELLIGENT SENSOR NETWORKING”)

OFFERED BY UNIVERSITY OF RWANDA

Visit to the university: 03 - 05 May 2022, written reconsideration evaluation in September 2025

Panel of experts:

Panel of experts in 2022 and 2025:

Prof. Dr. Celestine Iwendi University of Bolton (United Kingdom), School of Creative Technologies

Prof. Dr. Volker Lücken Trier University of Applied Sciences, Department of Engineering, Unit for Electrical Engineering

Panel of experts in 2022:

Dr. Matthias Winter Network Box Deutschland GmbH, Head Technical Pre-sales & Special Projects (representative of labour market)

Helena Lendowski Master student at University of Potsdam (student expert)

Coordinator:

Doris Herrmann

AQAS, Cologne, Germany

Dr. Mayada Woriedh

Preamble

AQAS – Agency for Quality Assurance through Accreditation of Study Programmes – is an independent non-profit organisation, supported by more than 90 member institutions, both higher education institutions (HEIs) and academic associations. Since 2002, the agency has been accredited by the German Accreditation Council (GAC). It is therefore a notified body for accreditation of higher education institutions and programmes in Germany.

AQAS is a full member of ENQA and also listed in the European Quality Assurance Register for Higher Education (EQAR) which confirms that our procedures comply with the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG), on which all Bologna countries agreed as a basis for internal and external quality assurance.

AQAS is an institution founded by and working for higher education institutions and academic associations. The agency is devoted to quality assurance and quality development of both academic studies and teaching in higher education institutions. The activities of AQAS in accreditation are neither limited to specific academic disciplines or degrees nor to a certain type of higher education institution.

I. Accreditation procedure

This report results from the external review of the Master and PhD programmes “Internet of Things” with specialisations in “Embedded Computing Systems” and “Wireless Intelligent Sensor Networking” offered by University of Rwanda.

1. Criteria

Each programme is assessed against a set of criteria for accreditation developed by AQAS: the AQAS Criteria for Programme Accreditation (Bachelor/Master) and the AQAS Criteria for Doctoral Programme Accreditation (PhD). The criteria are based on the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) 2015. To facilitate the review each criterion features a set of indicators that can be used to demonstrate the fulfilment of the criteria. However, if single indicators are not fulfilled this does not automatically mean that a criterion is not met. The indicators need to be discussed in the context of each programme since not all indicators can be applied to every programme.

2. Approach and methodology

Initialisation

The university mandated AQAS to perform the accreditation procedure in May 2021. The university produced a Self-Evaluation Report (SER). In July 2021, the institution handed in a draft of the SER together with the relevant documentation on the programmes and an appendix as well as, in case of a reaccreditation, statistical data on the programmes. The appendix included e.g.:

- Strategic plan of the university
- General Academic Regulations for Postgraduate Studies
- Module Descriptions of the Master’s programme
- Student Evaluation Form
- Guidelines for External Examiners
- Form for Student and Complaints.

AQAS checked the SER regarding completeness, comprehensibility, and transparency. The accreditation procedure was officially initialised by a decision of the AQAS Standing Commission on 30 August 2021. The final version of the SER was handed in December 2021.

Nomination of the expert panel

The composition of the panel of experts follows the stakeholder principle. Consequently, representatives from the respective disciplines, the labour market, and students are involved. Furthermore, AQAS follows the principles for the selection of experts defined by the European Consortium for Accreditation (ECA). The Standing Commission nominated the aforementioned expert panel in March 2022. AQAS informed the university about the members of the expert panel and the university did not raise any concerns regarding the composition of the panel.

Preparation of the site visit

Prior to the site visit, the experts reviewed the SER and submitted a short preliminary statement including open questions and potential needs for additional information. AQAS forwarded these preliminary statements to the university and to all panel members to increase transparency in the process and the upcoming discussions during the site visit.

Site visit

After a review of the SER, a site visit to the university took place on 9 – 11 May 2022. On site, the experts interviewed different stakeholders, e.g. the management of the higher education institution, the programme management, teaching and other staff, as well as students and graduates, in separate discussion rounds and consulted additional documentation as well as student work. The visit was concluded by the presentation of the preliminary findings of the group of experts to the university's representatives.

Reporting

After the site visit had taken place, the expert group drafted the following report, assessing the fulfilment of the AQAS Criteria. The report included a recommendation to the AQAS Standing Commission. The report was sent to the university for comments.

Postponement of decision

The report, together with the comments of the department, forms the basis for the AQAS Standing Commission to take a decision regarding the accreditation of the programme. Based on these two documents, the AQAS Standing Commission took its decision on the accreditation on 29 August 2022. AQAS forwarded the decision to the university. The university had the right to appeal against the decision or any of the imposed findings.

The AQAS Commission decided to give the programme additional 18 months for the further enhancement of the quality of the programme. The deadline for the submission of the revised documents was 31 March 2024.

Reconsideration

The university submitted further evidence in April 2024, and thus, in the given timeframe, for the reconsideration process. The documents were forwarded to the relevant key stakeholder in the experts' panel. The expert drafted this follow-up report on the consideration, assessing the fulfilment of the AQAS Criteria. The report includes a short description of the situation when the programmes were assessed firstly, the evaluation by the expert panel which formed the basis for decision taking in 2022, the assessment of the situation on the basis of the additional documents provided in 2024 and a recommendation to the AQAS Standing Commission.

Decision

The report, together with the comments of the university, forms the basis for the AQAS Standing Commission to take a decision regarding the accreditation of the programmes. Based on these two documents, the AQAS Standing Commission took its decision on the accreditation on 1 December 2025. AQAS forwarded the decision to the university. The university had the right to appeal against the decision or any of the imposed conditions.

In January 2026, AQAS published the report and the result of the accreditation as well as the names of the panel of experts.

II. General information on the university

The University of Rwanda (UR) consists of six Colleges which are spread across 14 campuses in several parts of the country: the College of Arts and Social Sciences, the College of Agriculture and Veterinary Medicine, the College of Business and Economics, the College of Education, the College of Science and Technology, and the College of Medicine and Health Sciences. The management of the university consists of a Board of Governors as the highest governing and decision-making organ, a Chancellor, who is appointed by Presidential Order and assumes a mainly ceremonial role, a Vice Chancellor, who acts as the CEO of the university, and three Deputy Vice Chancellors (DVC for Academic Affairs and Research, DVC for Administration and Finance, and DVC for Institutional Advancement). Further organizational units include the University Academic Senate, College Academic Councils, School/Centre Academic Councils, and Department Councils. As of 2021 the university reports an enrolment of 30.214 students in 67 undergraduate and 51 postgraduate programmes and an employment of over 1.300 academic staff.

The African Centre of Excellence in Internet of Things (ACEIoT) is part of the ACE II Project which includes three other ACEs, i.e. the African Centre of Excellence in Data Science, the African Centre of Excellence for Energy for Sustainable Development, and the African Centre of Excellence for Innovative Teaching and Learning Mathematics and Sciences. ACEIoT is established at the College of Science and Technology and located in Kigali. The Centre focuses on wireless intelligent sensor networks and embedded computing systems as two core areas. It aims to (i) promote cutting-edge research in the field of Internet of Things (IoT), (ii) train high-level professionals and academics through Master's and PhD programmes, (iii) increase applied research output in the field of IoT with relevance to the East and South African priority domains, and (iv) excel as a focal point for regional and international research collaborations.

The Master and the PhD-programme of the ACEIoT started with the student intake at the University of Rwanda in 2017/2018. Although the stakeholders confirmed that ACEIoT managed well to switch to online teaching during the pandemic, there is no doubt that the Corona crisis also had an impact on the development of the programmes and was a challenge for the new center. During the site visit it became clear that some aspects which assessed in an international accreditation procedure, for example the labs, were not implemented on the level which is usually required for a Center of Excellence. This delay in the development is not in the responsibility of the ACE as it is a result of the coronavirus pandemic. Nevertheless, it causes a methodological problem for the assessment of the two specifications.

III. Assessment of the study programmes

1. Quality of the curriculum / Aims and structure of the doctoral programme

Master degree

The intended learning outcomes of the programme are defined and available in published form. They reflect both academic and labour-market requirements and are up-to-date with relation to the relevant field. The design of the programme supports achievement of the intended learning outcomes.

The academic level of graduates corresponds to the requirements of the appropriate level of the European Qualifications Framework.

The curriculum's design is readily available and transparently formulated.

[ESG 1.2]

Doctoral degree

The intended learning outcomes of the programme are defined and available in published form. They reflect both academic and labour-market requirements and are up-to-date with relation to the relevant field. The design of the programme supports the achievement of the intended learning outcomes.

The academic level of graduates corresponds to with the requirements of the appropriate level of the national qualifications framework or the European Qualifications Framework.

The curriculum's design is readily available and transparently formulated.

[ESG 1.2]

Description

Master programme with two specialisations: *Embedded Computing Systems* and *Wireless Intelligent Sensor Network*

General information on the Master programme

The Masters programmes in Internet of Things aims to educate and train African researchers in the field of IoT. The SER describes that the programme has been produced to comply with the Rwandan National Qualifications Framework for Higher Education Institutions. Regarding its content, it has been benchmarked with the International Telecommunication Union (ITU) Post Graduate Course in Internet of Things to ensure that the proposed curriculum meets international standards.

Because IoT is a multidisciplinary field, the ACE decided to focus on the two main focus directions: (i) Wireless Intelligent Sensor Networking and (ii) Embedded Computing Systems. Both specifications have eight modules/courses with 170 credits out of the 240 credits in common (72% of the content).

In order to achieve the ILOs mentioned in the report, the curriculum is structured into two blocks. In the first years, students are introduced to the basic concepts and methodology related to the field of IoT. These compulsory core modules comprise 10 credits each and address (i) fundamentals of IoT, (ii) smart sensors and actuators, (iii) wireless sensor networks, (iv) designing and programming embedded devices, and (v) IoT entrepreneurship. Also, students are offered a two-week course in research methodology. First year courses are offered to students of both Master specifications.

The following courses are obligatory:

<i>Module code</i>	<i>Module Name</i>	<i>Contact hours</i>	<i>Credits</i>	<i>Level</i>
IOT6161	Fundamentals of Internet of Things	36	10	6
IOT6162	Smart Sensors and Actuators	36	10	6
IOT6163	Wireless Sensor Networks	36	10	6
IOT6164	Designing and Programming Embedded Devices	36	10	6
IOT6165	IoT Entrepreneurship	36	10	6
IOT6166	Research Methodology	36	0	6
ECS6361	Field Attachment	72	20	6
ECS6461	Masters Dissertation	360	100	6
Total		648	170	6

Specification Embedded Computing Systems

The Master's programme in Embedded Computing System (IoT:ECS) aims to provide students with practical introduction to sensors, actuators, and programming of sensor network nodes, to train embedded-system developers to generate power-efficient code for memory and power management/optimisation, and to endow students with knowledge about various RTOS kernels. Furthermore, students are said to be exposed to the system cores such as MCUs, DSPs, or FPGAs, to be supported in their development of a broad technical understanding of the IoT related ECS technologies and their application to real-world circumstances, and to gain relevant communication, interpersonal, and team building skills. According to the SER, these overall educational aims of the programme are further translated into specific intended learning outcomes (ILOs) with regards to knowledge and understanding (10 ILOs), cognitive, intellectual, and application skills (9 ILOs), practical, communicative, ICT and analytic skills (6 ILOs), as well as general transferable skills (5 ILOs).

For the second year, the curriculum schedules specialised modules with regards to embedded computing systems. These include modules on ultra-low power design techniques (15 credits), system on chip design (15 credits), edge and distributed computing (15 credits), IoT operating system (15 credits), and modelling and fabrication techniques (15 credits).

Core Modules for Masters of Embedded Computing Systems

<i>Module code</i>	<i>Module Name</i>	<i>Contact hours</i>	<i>Credits</i>	<i>Level</i>
ECS6261	Ultra Low Power Design Techniques	48	15	6
ECS6262	System on Chip Design	48	15	6
ECS6263	Edge and Distributed Computing	48	15	6
ECS6264	IoT Operating System	48	15	6
ECS6265	Modelling and Fabrication Techniques	36	10	6
Total		228	70	6

Furthermore, students are to conduct a two-months-long practical training in the industry ('field attachment', 20 credits). Students can choose whether they would like to complete their studies with a dissertation or with a final project, which should include the design of a prototype, a solution to a real problem, or a related research publication in an international journal. Both options include a written part and an oral defence and count 100 credits.

Specification Wireless Intelligent Sensor Network

As stated in the SER, the educational aims of the Master's programme on Wireless Intelligent Sensor Networking (IoT:WISN) include (i) to provide students with practical exposure to different types sensors, actuators, and programming of sensor network nodes, (ii) to enable students to model, simulate, predict and assess the performance of communications over Wireless Sensor Networks, (iii) to provide hands-on sessions for the implementation of small-scale applications, (iv) to expose students to a wide range of testbeds available for projects, such as internet technologies, wireless networking, network management and control, IoT applications, (v) to develop a broad technical understanding of the IoT technologies applied for development and business in a real-world contexts, and (vi) to develop communication, interpersonal, and team building skills. These aims are further specified by 10 ILOs with regards to knowledge and understanding, 10 ILOs concerning

cognitive, intellectual, and application skills, 6 ILOs on practical, communicative, ICT and analytic skills, and 5 ILOs describing general transferable skills.

Core Modules for Masters of Wireless Intelligent Sensor Networks

<i>Module code</i>	<i>Module Name</i>	<i>Contact hours</i>	<i>Credits</i>	<i>Level</i>
WSN6261	IoT Architecture, Protocols and Standards of WSN	48	15	6
WSN6262	Security, Privacy and Ethical Aspects of WSN.	48	15	6
WSN6263	Advanced Wireless Sensor Networks Design in 5G	48	15	6
WSN6264	Cloud Networking for 5G	48	15	6
WSN6265	Applications of unmanned Aerial Vehicle in IoT	36	10	6
Total		228	70	6

The curricular structure matches that of the IoT:ECS programme. Students of both programmes have to obtain 50 credits in compulsory core modules (fundamentals of IoT; smart sensors and actuators; wireless sensor networks; designing and programming embedded devices; IoT entrepreneurship) and are offered a two-week course on research methodology. Subject-specific modules of the IoT:WISN programme start in the second year and include (i) IoT architecture, protocols and standards of WSN (15 credits), (ii) security, privacy, and ethical aspects of WSN (15 credits), (iii) advanced wireless sensor network design in 5G (15 credits), (iv) cloud networking in 5G (15 credits), (v) applications of unmanned aerial vehicles in IoT (10 credits).

Furthermore, students are to conduct a two-months-long practical training in the industry ('field attachment', 20 credits) and can choose whether they would like to complete their studies with a dissertation or with a final project, which should include the design of a prototype, a solution to a real problem, or a related research publication in an international journal. Both options include a written part and an oral defence and count 100 credits.

Experts' evaluation of Master's programme

a) Evaluation in 2022

The panel of experts has no concerns that the overall qualification corresponds to Master's level of the National and European Qualification Framework and that the intended learning outcomes can be achieved. The intended learning outcomes include subject-specific and interdisciplinary elements. All curricular elements including their functions, their compulsory or elective character and their usage is documented. An idealised typical course plan is available.

The curricular structure of the programme supports the achievement of the intended learning outcomes and the learner's progression. The curriculum covers mostly subject-specific knowledge but also offers some courses which address methodological and general skills. Because the programme is relatively new, no curricular modifications took place on course level up-till-now. Usually, revisions of the programmes should take place at the University of Rwanda every 4-5 years.

Both specialisations in the Master's programme basically cover the proper spectrum of current technologies and applications, which are essential for both employability and labour market requirements as well as academic capabilities.

Analysing the specialisations and their implementation in general, the majority of the comments covers both specialisations jointly. In this regard, the general expert evaluation of the Master's programme is as follows:

Alignment of Module Handbook:

Within the module/course handbook, the underlying Intended Learning Outcomes (ILOs) of the courses require a further consolidation and alignment with the subject aims, in order to provide a more consistent description of the specific modules' focus. For example, consider the module "IoT Architecture, Protocols and Standards": while all relevant standards are listed, the breadth of the module is far too large. Students informed the panel of experts during the site visit that an overview of the named communication standards in the "Subject aims / Content" section is provided, which is appreciated. But on the point of view of the experts, it is necessary to differentiate in the module handbook between topics and technologies that are considered in-depth and that are also related to competencies gained by the students in applying them and technologies about which the students are informed on the level of basic knowledge. This also applies for other modules. The module descriptions must be revised in a way that clear information are given if the students can gain core competencies in a certain area or if only some general information on this topic are given by the lecturers.

Although the intended learning outcomes reflect both academic and labour market requirements to some extent, the descriptions should be sharpened in a way that the ILOs address clearly the needs of both areas. According to the teaching staff, the intended learning outcomes are updated by the ACEIoT. Nevertheless, during the site visit several content related aspects were discussed which cannot be found in the module handbook so that it is recommended to include more current developments in the descriptions.

It remained unclear if a coordination and revision of the course descriptions of the programmes offered by the colleges takes place on a central level at the University of Rwanda. This could be helpful and function as one element of international quality assurance.

Student surveys and the exchange with the labour market are instruments to check the appropriateness of the ILOs.

During the site visit the experts got different answers from the stakeholders regarding the workload of the courses. They got the impression that formally seen the workload is defined and available to students and teaching staff, but that students are how high the workload should be. Also, a regular check of the workload, for example as part of the student surveys, seems to be missing. Therefore, the workload management of both, course handbook and practical implementation, necessitates optimization, as it does not provide a transparent overview and differentiation.

Practical experience and employability:

The Master and PhD programmes cover the most important theoretical topics in the field. A solid knowledge base alone however is not sufficient to meet labour market needs and to tackle the regional problems. The programme addresses many regional challenges and will yield the desired outcome once the proponents' efforts are aligned to maximize synergies. A close feedback loop with the industry may help steer the programmes towards cutting edge in science and application. Experimental practice and real-world problem-solving skills are critical for student motivation and knowledge retention. Therefore, practical and industry internships should be mandatory in the first year of the programme. These early connections with potential employers help students align their study focus with business needs.

The attractiveness of a study programme depends largely on the perceived return on investment for the students. In order to attract a critical mass of highly motivated students, meet the ACEs goals in reaching scientific excellence, building competent teaching staff and fostering strong industry cooperation, the programmes need

a professional and up to date presentation. This should be supported by project success stories and in the form of a strong alumni network.

Synchronization between modules in regard to tooling and programming languages:

The inter-module application of different tools (e.g., programming languages, simulation tools, hardware boards) is not documented and synchronized within the module handbook, which reduces synergetic potentials and a proper methodological and applicational flow over the different courses and semesters. For example, programming languages should be tailored to the requirements of the students (e.g., C language for hardware-related programming, Python language for higher-level signal processing). Otherwise, the initial threshold for student's success within every module, requiring to potentially learn a new tool skill, is too high.

Flexibility / elective courses:

Both specialisations in the Master's programme are very inflexible in terms of elective courses, e.g., with students selecting elective courses from the other programme, or deciding on courses based on personal preference and career planning (e.g., selecting / deselecting IoT entrepreneurship). While the differentiation between both specialisations (Embedded Computing Systems and Wireless Intelligent Sensor Networking) is very reasonable and applicable, the intersection between both specializations could be increased based on individual students' preference. Instead of a fully predetermined study plan, a more modular approach could thus help students refining their strengths. Adding a choice of courses for scientific writing, research methodology, teaching approaches or topical specialization courses in the second half of the curriculum will yield better specialized graduates with a stronger personal profile. This could be done with little extra effort and even strengthen the bonds between different colleges opening pathways to interdisciplinary work.

Succession of block courses:

The courses with different topics follow a very tight succession, with limited possibilities for a personal follow-up of the content by the students, or a further deep-dive and qualification-building. This is also confirmed by the feedback of the students during the site visit. Here, the need for a longer post-processing phase (e.g., by gaps, a larger time spread or overlapping courses) was mentioned to provide the means for an improved consolidation of the acquired knowledge – which is especially relevant for this type of university education in contrast to school programmes.

Lab equipment and presentation:

The labs provide basic lower-budget equipment (e.g., soldering stations, oscilloscopes, logic analyser interfaces) and some components for realizing applications (e.g., Arduino boards, a set of DJI drones). However, for a university-based education, the lab equipment requires an adaptation to more sophisticated and complex systems, e.g., communication systems and System-on-Chips. Also, the lab environment must be adjusted to provide a better teaching framework and preparation, such as pre-configured workstation computers in contrast to students providing their own laptops, which creates barriers by unnecessary installation and configuration efforts.

Finally, there is a strong lack in the dissemination of students' results, e.g., by operable high-quality demonstrators and posters. Considering the posters and demonstrators presented in the laboratory, the scientific quality showed significant limitations.

The attractiveness of a study programme depends largely on the perceived return on investment for the students. In order to attract a critical mass of highly motivated students, to meet the ACEs goals in reaching scientific excellence, to build a competent teaching staff and to foster strong industry cooperation, the programmes need a professional and up-to-date presentation. This should be supported by project success stories and in the

form of a strong alumni network. The programme addresses many regional challenges and will yield the desired outcome once the proposed efforts are aligned to maximize synergies.

Some expert comments target only one of the specific specializations:

Embedded Computing Systems

- IoT Operating Systems: The subject aims to cover a far too wide range of topics, e.g., consider the section “IoT Operating systems Case studies”, which are more of an overview, but not in-depth case studies. Here, also the relevance of the selected aims and the learning outcomes should be evaluated, as students will probably not “produce innovative designs of real time operating systems” (from “learning outcomes”) in practice but will apply them onto specific applications.

Wireless Intelligent Sensor Networks

- Communication system knowledge: As mentioned before as an example in the generic part, the module “IoT Architecture, Protocols and Standards” requires a confinement. Of course, a substantial overview on the different standards and protocols should be given, however, these should still be selected by market and research relevance. Further, the focus should also be on the core communications, therefore, understanding the underlying principles, architectures and algorithms behind these (selected) standards is of essence.
- Modelling and Fabrication Techniques: The module “Modelling and Fabrication Techniques” should also be (optionally) available for the “Wireless Intelligent Sensor Networks” specialization, as the CAD and 3D printing techniques have high relevance especially in the development of suitable sensors as a basis for the applications.

Reconsideration evaluation in 2025:

In the revised programme specifications, the learning outcomes are now listed in a matrix form and are enhanced compared to the initial state. They are also reflected in the curriculum.

However, several learning outcomes are very generic and overlapping (e.g. MSC IoT-ECS learning outcome B1 “Critically analyse IoT use cases and apply appropriate technologies for innovative designs of IoT system solutions”, being covered by 5 courses). A further distinction of the learning outcomes, tailored to the very specific courses, would therefore be preferable (**Finding 1**).

The management of the student workload has been improved with better distributed/aligned contact hours.

Practical and industry internships have been integrated in the Masters’ curriculum to focus on business needs.

The inter-module application of different tools has been extended in the curriculum for IoT Master, however, they are still sparse. For several courses (e.g. ECS6263, focus there e.g. „Building predictive models with Supervised ML”, but programming language and frameworks not mentioned), the specifications are missing and still inconsistent (**Finding 2**). To better allow the students to develop a personal profile, a choice of courses for scientific writing, research methodology, teaching approaches or topical specialization courses are offered in the second half of the Master’s curriculum.

Didactical approaches have been implemented to allow students to follow-up on the content of the block courses.

The lab environment has been adjusted to provide a better teaching framework and preparation, such as pre-configured workstation computers.

Ways of professional and up-to-date presentation have been implemented in the programmes which also include project success stories, a strong alumni network and the dissemination of students’ results.

Case studies have been implemented into the curriculum of the Masters' programme.

Conclusion

The criterion is fulfilled.

PhD programme Internet of Things with two specialisations: *Embedded Computing Systems* and *Wireless Intelligent Sensor Networking*

General remarks on the PhD programme

According to the SER, a PhD by Research shall be awarded to a candidate who has critically investigated an approved research project resulting in an independent and original contribution to the body of knowledge, has demonstrated an understanding of research methods appropriate to the chosen field, and has presented and defended a thesis in oral examination to the satisfaction of examiners. Students of this PhD programme shall take research methodology and academic writing modules as mandatory and non-credit bearing modules. The total credit units for the qualification is 360. The study period is 4 years full time.

Students should successfully complete a minimum of four courses from which two core modules are prescribed by the Doctoral Committee. The course work shall be completed within a period of the first three semesters. Both categories of modules are non-credited and shall be assessed on a PASS/FAIL basis. At least two should be selected from core disciplinary modules and compulsorily Research Methodology and English for Communication purposes from generic skills modules. Those modules are offered to Master's students and the PhD students will be required to take them with Master's students.

S.No.	Category	Index	Section	Year 1		Year 2		Year 3		Year 4	
				Semester-1	Semester-2	Semester-3	Semester-4	Semester-5	Semester-6	Semester-7	Semester-8
1	Preliminary Activities	1.1	Induction week	First week							
		1.2	Initial Proposal presentation & Allocation of Core Graduate modules by Doctoral Committee	Third week							
2	Research Progress Related Activities	2.1	Core Disciplinary Graduate Module completion - (2)		1 core	1 core					
		2.2	Minor Generic Skills Module - compulsory (2)		1 generic	1 generic					
		2.3	Literature review & Data Collection for PhD Thesis								
		2.4	Comprehensive Exam by Doctoral Committee on Extensive Research Proposal & Research Progress at the 4 th Semester beginning (REQUIRE a PASS for Doctoral Candidature)				Comprehensive Exam				
		2.5	Continue with PhD Research work								
		2.6	Semester Wise Progress Report Submission (8)-submitted during first week of June and December every year.	1	1	1	1	1	1	1	
		2.7	Presentation of Synopsis at Doctoral Committee (during the last three months of 7th semester). APPROVAL GIVEN FOR THESIS WRITING.								PhD Synopsis presentation
		2.8	Submission of Thesis and Final Viva Voce defense								
3	Other Mandatory Activities	3.1	Seminar Presentation at Center/School Level (2)			1 seminar		1 seminar			
		3.2	Workshop attendance (2)					1	1		
		3.3	Conference Paper Publications (1)				MAX time limit				
		3.4	Journal Publications (2)							MAX time limit	
		3.5	Industrial Attachment (3 to 4 months) (1)								
		3.6	UR Research and Innovation week attendance (4)		1 week		1 week		1 week		1 week
		3.7	Graduation								1 DAY

Embedded Computing Systems

Graduates of the PhD programme on The Internet of Things: Embedded Computing Systems are said to be qualified for an academic career as well as for employment in industry linked to the application of IoT, especially sectors such as agriculture, energy, health, or transportation, amongst others. Students' research projects are said to focus on sub-fields such as hardware architectures of embedded systems/processors, microsystems such as sensors, system-on-chip design, automation and control, cyber-physical systems, system automation, smart devices, sensors, actuators for new application areas, or embedded computing for wireless sensor systems. Following the educational aims of the programme presented in the SER, PhD students are said to (i) critically apply theories, methodologies, and knowledge to address fundamental questions in the field of ECS, (ii) pursue research of significance in the ECS discipline or an interdisciplinary or creative project in IoT, (iii) demonstrate skills in oral and written communication sufficient to publish and present work in their field (iv) follow the principles of ethics in the IoT-ECS field of research and in academia, (v) demonstrate, through service, the value of the ECS field applied to IoT to the academy and community at large, and (vi) demonstrate a mastery of skills and knowledge at a level required for college and university undergraduate teaching in the ECS field and assessment of student learning. These aims are further specified in the form of course specific ILOs.

As explained above, the PhD students have to study several courses on MA level so that a range of content on IoT is covered. In addition, students are also required to publish at least three papers in international, peer reviewed journals and conferences indexed by Scopus and SCI.

Students are provided with an ideal research timeline, which includes the major milestones to be achieved and which is divided into preliminary activities (i.e. introduction week, initial proposal presentation), research progress related activities (e.g. course attendance, literature review, synopsis presentation, amongst others), and other mandatory activities (e.g. seminar presentations, workshop attendances, industrial attachment, amongst others).

Student mobility is said to be fostered by exposure to visiting lecturers, participation in international conferences, and exchange programmes for a two-month stay at partner universities or industries.

Wireless Intelligent Sensor Network

Graduates of the PhD programme on The Internet of Things: Wireless Intelligent Sensor Networking are said to be qualified for an academic career as well as for employment in industry linked to the application of IoT, especially sectors such as agriculture, energy, health, or transportation, amongst others. Students' research projects are said to focus on sub-fields such as wireless sensor networks and communication protocols, intelligent data, processing and semantic technologies, energy harvesting for wireless sensors, middleware of WSN, and security of sensor networks.

The educational aims of the programme presented in the SER state that students are to learn to (i) identify new problems arising from recent developments in and related to the WSN domain and the ability to assess the potential impact of such developments on society, (ii) conduct ethically and scientifically sound research in WSN, (iii) successfully conduct and manage research undertakings which may include aspects not only from WSN domain but also from other domains within the discipline of IoT, (iv) apply current abstract research and methods within the chosen research domain to specific problems in creative and innovative ways, (v) critically apply theories, methodologies, and knowledge to address fundamental questions in their primary area of study, and (iv) organize and participate in research and development through established national and regional research frameworks. These aims are further specified in the form of course ILOs.

The structure and organisation of the IoT:WISN PhD programme matches that of the IoT:ECS PhD programme. Students receive 360 credits for their dissertation and defence and have to successfully pass four modules, two of which are 'Core Disciplinary Graduate' modules (see list of courses offered in the IoT:WISN Master's programme) and two of which are to be chosen from the 'Minor Generic Skills' modules. Also, students are required to publish at least three papers in international, peer reviewed journals and conferences indexed by Scopus and SCI. According to the university, students have the option to participate in exchange programmes and international conferences.

Experts' evaluation on PhD

a) Evaluation in 2022:

General remarks on the programme

The panel of experts appreciate that ACEIoT conceptualised a PhD programme and managed to get funding from World Bank. The chance to establish a programme which graduates are needed by the labour market and which also has an impact on the University of Rwanda internally (staff and other colleges) has been taken by the persons in charge of the programme. The panel considers the programme as valuable for the further development of the University but also for the country. It is a modern approach to offer a programme of Internet of Things at the University of Rwanda. Nevertheless, some aspects are not completely satisfying in the opinion of the panel members. Perhaps more time would have been needed after the introduction of the programme to elaborate the programme's outreach and the programme's sustainability after the funding from World Bank will expire. Some aspects the programmes' concepts show shortcomings, for example it is not clear if internal or external staff will take over the supervision of the PhD thesis. Regarding other aspects more time would have been needed to employ an adequate number of PhD holders among the teaching staff which has also some industrial experience (see chapter 5).

The panel of experts is also convinced that the qualification of the applicants will have a severe impact on the output of the programme and its reputation in the future. The process of admission is well defined, but it stayed unclear during the discussions at the site visit if also aspects like entrepreneurship and innovation are considered to be relevant for admittance. In the opinion of the panel members these aspects will be crucial for the success of the graduates in the labour market and help to avoid that student will struggle to get employment.

ACEIoT should also consider that the level and number of publications is crucial for the future success of PhD holders who try to enter academia or the labour market. Therefore, the panel of experts who checked some of the publications of the PhD students during the site visit, see the need to enhance the level of the publications as well as the number of papers. With the requirement to publish two journal papers and one conference paper till graduation, the student cannot be competitive in labour market.

The resources provided for research also need improvement like explained below in this report. Especially the library needs more attention because it plays a crucial role for the research output (see chapter 6).

The PhD students have to take courses from the Master's programme so that the course descriptions for the PhD programme are alike. Therefore, the same feedback which was given by the experts to the Master's programme of IoT is applicable for the PhD: the course descriptions have to be revised, especially the ILOs.

Because the programme is relatively new, some steps cannot have been taken, like the revision of the programmes on the basis of the feedback from the labour market which employs the graduates. The proof that the ILOs are appropriate, e.g. by evaluations, graduate surveys and/or feedback from the labour market, has to be collected in the future.

The curriculum covers subject-specific as well as subject-related, methodological and general skills. It provides a structure like explained above. ACEIoT handed in a time-plan with key milestones of doctoral research set up which is used for orientation and guidance throughout the duration of studies. During the site visit the students also mentioned that the information on the courses is provided too late, so that ACEIoT should take care of up-to-date and early information of the students to enable them to plan their courses properly. The courses need to have electives and should be clearly documented so that student are aware of all relevant information on time. Brochure needs to be provided stating all these details.

The panel got the impression that the university collaborates well with the labour market. However, some representatives of the labour market mentioned in the discussion that the students need additional training by the companies after graduation and that they would appreciate if also other skills and competencies would be included in the curriculum. This is an issue for long term goals of UR and sustaining such system with large number of students. ACEIoT should strengthen the exchange with the labour market on the range of qualifications needed by industry without giving up the academic standards which are needed from university perspective.

The panel of experts welcomes that an internship is included in the programme. If the duration is two months, it would be too short for industrial attachment and for students to get a real benefit from it. ACEIoT should work on ideas how the integration of students in the labour market can be enhanced. The panel of experts supports the intention of UR to offer the study programme in part-time. This could help to increase the number of students who are already working and who want to get a higher qualification. This could also be a way to strengthen the practice orientation of the PhD programme.

The aspect of internationalisation is there in the programme but should be strengthened in the future. Students should be encouraged to go abroad and to apply themselves at other universities in Africa or overseas. Flexibility is needed and courses obtained should also be transferred and added up for them.

The majority of the students are all funded or are staff of the institution. The school has not attracted self-funded students because there is no mechanism in the system in place for that.

The PhD programme strives to reach the appropriate level of the National and European Qualification Framework and explanations have been given during the site visit why courses from the Master's programme are included. Nevertheless, the panel of experts did not manage to get a clear picture how ACEIoT guarantees by regulations for admittance, structural aspects in the curriculum, supervision and dissertation that the PhD level can be reached. There is no doubt that the achievements and the workload of the students are impressive and that the teaching staff is supportive to make them reach a high educational level. However, structural measures seem to be lacking to provide a high quality of the outcome steadily and reliable.

The panel of experts has no doubts that the overall workload of students and teaching staff seems to be high. During the site visit the question was discussed how the teaching staff manages to teach in the undergraduate courses as well as on Master- and PhD-level, to supervise the students in the graduate programmes, to carry out own research projects and to respond on administrative requirements of the ACE (see chapter 5). Like for the Master's programme, there seems to be a lack of awareness of the workload of students and staff which makes it difficult for the panel of experts to assess if the workload is appropriate. The University of Rwanda should implement instruments to measure the workload of students and staff as part of its internal QA system.

Specification Embedded Computing Systems

As explained above, the programme structure should be revisited. Instead of including the PhD students in the courses of the Master's students, subject specific courses on PhD level should be offered. It must be made clear that these (elective) courses are offered on the adequate level of the National or European Qualification

Framework. The learning outcomes should be focused on skills, choice of career, and areas of strength for the student (see Finding 1).

Because the programme is relatively new, there was no graduate who could have given information on the final thesis method during the site visit. The experts see the danger that due to the huge workload and the examinations in four courses which have to be taken jointly with Master's students, there is a lack of time for the students to study on PhD level and to focus on their research properly. Therefore, it is recommended to restructure the programme and develop a more student friendly time plan for implementation.

Specification Wireless Intelligent Sensor Network

The needs of revision of the Specification Embedded Computing Systems are similar to the other specification. The panel of experts noticed that the ILOs for the programmes at ACEIoT are described, but there are concerns if the Learning Outcomes can be reached as intended due to a lack of resources. The programme structure should be revisited. Subject specific aspects are lacking and students are made to take three courses with Masters students. It equates them as Master's student. There are no specific elective courses for PhD students. Students complained that the courses are mostly not communicated to them in due time. Lack of proper planning and execution of learning outcomes seems to be an issue. The learning outcomes should be focused on skills, choice of career, entrepreneurship and areas of strength for the student (see above).

The programme allocates three supervisors: one external from partner universities (some in Europe) and two local supervisors that meet every week to discuss with the students. Students complained that they have no time to meet with the demands of the supervisors and have no time for their own creativity. The programme should be structured to give student time to work on their own and come up with their own initiatives (see above). The huge workload and the examination of four courses with Master's students give a wrong impression and lack of time to prepare by the students to pass the courses.

b) Reconsideration evaluation in 2025:

The number of papers was enhanced and the level requirements are mentioned in the statement by the university (which would be sufficient for the fulfilment of the finding), but the corresponding information are not reflected in all documents (e.g. 3.6 is updated, but 3.8 / 3.13 are still mentioning two journals instead of three, and not the further requirements). The measures have been implemented, but the documents need to be updated accordingly (**Finding 3**).

ACEIoT took care of up-to-date and early information of the students to enable them to plan their courses properly.

The internships have been enhanced and the exchange with the labour market has been extended. UR updated all specifications according to the formulated requirements.

Several international cooperation agreements have been signed, as well as first exchanges been conducted.

The University submitted a structured roadmap and entry requirements to cover this aspect which is sufficient to fulfil the finding.

Conclusion

The criterion is partially fulfilled.

2. Procedures for quality assurance

Master degree

The programme is subject to the higher education institution's policy and associated procedures for quality assurance, including procedures for the design, approval, monitoring, and revision of the programmes.

A quality-oriented culture, focusing on continuous quality enhancement, is in place. This includes regular feedback mechanisms involving both internal and external stakeholders.

The strategy, policies, and procedures have a formal status and are made available in published form to all those concerned. They also include roles for students and other stakeholders.

Data is collected from relevant sources and stakeholders, analysed, and used for the effective management and continuous enhancement of the programme.

[ESG 1.1, 1.7 & 1.9]

Doctoral degree

The programme is subject to the higher education institution's policy and associated procedures for quality assurance, including procedures for the design, approval, monitoring, and revision of the programmes.

A quality-oriented culture, focusing on continuous quality enhancement, is in place. This includes regular feedback mechanisms involving both internal and external stakeholders.

The strategy, policies, and procedures have a formal status and are made available in published form to all those concerned. They also include roles for students and other stakeholders.

Data is collected from relevant sources and stakeholders, analysed, and used for the effective management and continuous enhancement of the programme.

[ESG 1.1, 1.7 & 1.9]

Description

As stated in the SER, policies and procedures of quality assurance are set in place according to regulations of the Higher Education Council of Rwanda (HEC) and the National Qualifications Framework which is also part of the appendices. UR applies the regulations of the HEC Quality Assurance handbooks to assure high quality inputs and outputs of curricula and receive the HEC's approval of new study programmes. Also, programme and institutional audits are carried out by the HEC on a regular basis. Further external quality insurance is provided by monitoring through the East African Quality Assurance Network Inter University Council for East Africa (IUCEA).

Internal QA procedures is said to involve various responsible units and actors, such as the Departments, School Councils, external reviewers, the College Directorate of Teaching and Learning Enhancement, the College Academic Council, the university Directorate of Research Innovation and Postgraduate Studies, and the University Senate. According to the UR, internal monitoring and evaluation of both individual courses and whole programmes is conducted based on an internal quality framework. The University also provides a set of academic regulations and policies on their website, which includes information on assessments, teaching methods, research degrees, progress reports, peer reviews of teaching, or module development.

The annual evaluation of Master's programmes is said to fall under the responsibility of the Head of Master's Studies and concerns the quality of ILOs, course structure, and potential needs for more in-depth evaluations. With regards to the evaluation PhD programmes, the report mentions the International Scientific Advisory Board (ISAB), which has been established by the Centre and involves representatives and partners from different universities, institutions, and industries. For both Master's and PhD programmes, the SER highlights the involvement of several stakeholders in curricular revisions, such as students, alumni, and labour market representatives.

Relevant information and feedback is said to be collected via regular tracer studies, workshops, and annual meetings. Data is said to be collected with regards to student progression and success rates (via the Office of the Director of Teaching and Learning Enhancement), the employability of graduates (via tracer studies and alumni feedback), students' satisfaction with their modules and courses (via end-of term evaluations), teaching quality (via lecturers' self-assessment and student feedback, involving the Head of Programme), the profile of the student population (via the College Registrar's Office), and the availability and quality of learning resources (involving lecturers' reports to the Head of Studies).

The university also states that regulations are put in place to manage conflicts and prevent discrimination. Students are advised to address the Head of Department or the Programme Coordinator. If disputes cannot be solved on that level, the Director of Research and Postgraduate Studies will be involved. Academic integrity is said to be safeguarded with the help of special tools and software to detect plagiarism. Also, the course on research methodology, which is available to all Master's and PhD students, addresses the aspects of scholarly conventions, referencing, and plagiarism.

Experts' evaluation

a) Evaluation in 2022:

The panel of experts understands from the SER and the site visit that the University of Rwanda has several instruments in place to check the quality of its programmes on different levels. There is no doubt, that ACEIoT reacts on student complaints and strives to check the quality of its programmes continuously. The University of Rwanda handed in additional documents on the QA system during the site visit. The programmes were introduced 2017/2018 so that the development process is still ongoing and no major revision of the programmes could have been taken place. It is clear to the experts that University of Rwanda has a QA system and a range of instruments implemented, but it was difficult for the experts to understand how the different levels of the system (central level, faculty level, ACE's level) are interlinked and contribute to the continuous assessment and enhancement of the quality of teaching and learning.

Due to the fact that the responsibility of the Master's and PhD programmes lies within the ACEIoT, it stayed unclear to what extent the programmes are subject to the university's policy and associated procedures for quality assurance and in which areas the ACE acts autonomously. The University of Rwanda has a set of widely agreed QA instruments in place but it needs to be explained to what extent the quality assurance system involve different scopes, such as course and/or programme evaluations, evaluation of student workload, progression & completion rates and/or further evaluation tools. It must also be explained what responsibilities and targets have been defined and how far are they adequate for the monitoring and revision of programmes.

The panel is convinced that the University of Rwanda is committed to take action on the basis of its surveys and evaluations, but it needs to be demonstrated in which ways quality assurance procedures lead to concrete measures to enhance quality or address identified findings. ACEIoT should keep track on its measures taken, for reasons of transparency for its stakeholders but also for accountability. For reasons of transparency for external and internal stakeholders the whole QA system must be described including its interlinkages on different level, the instruments in use on these levels and the responsibilities. It would be easier to understand the QA system if its presentation would be more process oriented.

Within the QA system it should be described how feedback from external stakeholders (e.g. labour market representatives) is collected regularly and systematically. It should also be made clear in the processes that the results of the evaluations are shared with teaching staff and students, at least in an aggregated manner.

It must be shown that internal QA instruments address each programme but also the individual courses so that the programme as such but also the teaching and learning process in the courses can be assessed.

Additionally for PhD, it must be described how the quality assurance mechanisms guarantee that the selection of the doctoral research topic, the assessment of the required doctoral research results and the award of the doctoral degree comply with accepted academic standards of the NQF of Rwanda.

Added to the QA instruments data must be collected to monitor students' background, average study duration and minority groups.

With the SER a paper based course evaluation form was provided. The panel of experts learned after the site visit that there are digital evaluation forms which also include free text fields for students' concerns. The panel encourages UR to extend the digitisation of its internal QA processes.

The ACE claimed they have a robust collaboration with alumni. What is not seen is the impact of such collaboration and if there is any way the alumni leadership were engaged in the leadership of the centre. The views of the alumni will help shape the centre and move it forward with new initiatives. For future development of the programmes, tracking of alumni (both programmes) should be carried out in order to understand market / employability / research career needs. Together with an active acquisition of feedback from alumni, the different QA instruments can help to create a closed loop between the level / yield of the alumni and the courses / focal areas during the programmes.

The panel of experts noticed that there is a relatively high number of committees. The high number of committees seems to be the cause for the relatively high workload of the staff - teaching in the ACE as well as in other departments. The expert panel is concerned how much time the teaching staff spends in committee meetings and how effective those meetings are in changing the topics discussed. The panel of experts does not see it as its task to give advice to the internal organisation of the ACE/UR but recommends to consider if the administrative overhead of the meetings is balanced in regard to the output and if there is enough personnel to ensure that committee decisions are being put into practice.

In the re-accreditation process of the Master and PhD programmes it would be interesting to see QA committee documentation, action plans, etc.

b) Reconsideration evaluation in 2025

QA policies, tools and instruments are inherited from University level to ACEIoT for the PhD programmes, topics are approved by an extended doctoral committee, and the progress is monitored. Also, external examiners ensure a sufficient academic standard.

Data collection for students is said to be extended in the future. Based on the documents of the university, digitisation processes have been initiated, also as first steps in e-learning system. Tracer surveys for tracking of alumni were implemented by the university.

Conclusion

The criterion is fulfilled.

3. Learning, teaching and assessment of students / Learning and assessment of students

Master degree

The delivery of material encourages students to take an active role in the learning process.

Students are assessed using accessible criteria, regulations, and procedures, which are made readily available to all participants and which are applied consistently.

Assessment procedures are designed to measure the achievement of the intended learning outcomes.

[ESG 1.3]

Doctoral degree

The form of supervision and/or course structure is adequate and corresponds with the intended learning outcomes.

Students are assessed using accessible criteria, regulations, and procedures, which are made readily available to all participants and which are applied consistently.

Assessment procedures are designed to measure the achievement of the intended learning outcomes.

[ESG 1.3]

Description

In general, the SER highlights the focus on student-centred learning, collaborative learning, and problem-based learning in both programmes. The learning and teaching approach in the Master programme at ACEIoT is aligned with the modular structure of the curriculum, which means that each module is organised to be taught in full-time (in blocks of 5 days per week). Usually, the first part of such a module is taught in a lecture-based classroom presentation and, towards the later stages of the module, may involve students' self-study via e-learning activities. Each module has a component called 'Research Seminar' where students present and discuss their projects, which are usually simulation-based or experimental. All students are said to be provided with the relevant study materials, assignments, exercises, guidelines, templates, and supplementary materials.

The teaching methods applied in the Master programme are said to depend on the module format. Modules that focus on theory and do not provide any credits (e.g. the module on research methodologies) will involve 36h of lectures and assignments, with a focus on encouraging students to learn and work independently. Modules that combine theoretical approaches with practical experience involve 36-48h of contact hours in the form of lectures, tutorials, discussions, seminars, case studies, etc., 26-42h of self study, and 38-60h of written assignments, practical work, and mini projects. The field attachment module is organised into 176h (22 working days) of field placement and 24h of report writing. The university states that each module's ILOs are considered with regards to employability and career development.

With regards to PhD students' learning process the SER mentions that in addition to the passing of four selected courses from the Master's programme, students also have to hand in a six-month progress report to their supervisors every semester, which documents the achieved research activities and proposes a plan for the activities scheduled in the following six months. Also, individual supervision is said to be guaranteed in order to foster the academic progress of students' research.

All regulations with regards to assessments methods, grading scales, and requirements published in the UR's General Academic regulations for Postgraduate Studies. Assessment methods are said to depend on the type of courses, i.e. the zero-credit modules are assessed as failed or passed based on the quality of class assignments. Modules with 10 or 15 credits involve the assessment of in-class activities (60%) and an end-of-module assignment, which usually a final exam (40%). In-class assessments may involve quizzes, practical assignments, presentations, short practical tests, or short written tests, and should have equal theoretical and practical components. Exam dates are said to be announced at the beginning of each module. Students are said to have the opportunity to re-sit exams. The assessment of the field attachment module is based on the student report, an intermediate and final evaluation of the company supervisor, and a work certificate from the company.

The university states that it monitors the number of failed module examinations on a regular basis. This data is carefully evaluated, and necessary changes are implemented with regards to programme requirements, as

demonstrated in the SER. Masters' theses are evaluated according to a written report as well as defence involving a presentation and oral examination by external examiners.

The examination of a PhD project includes (i) initial proposal presentation in the first three weeks of the first semester, (ii) comprehensive oral examination for doctoral candidature in the fourth semester, (iii) PhD synopsis submission and presentation upon satisfactory completion of at least three research papers in the seventh semester, (iv) thesis submission and external expert assessment, including assessment by three external examiners, one of which should have international background, (v) oral defence.

Experts' evaluation

a) Evaluation in 2022:

In the opinion of the expert panel, the learning and teaching methods contribute to a student-centred learning environment. Within the framework of the research seminars and practical work, students can choose their topics or applications according to their own interests. The panel of experts recognizes the opportunity for students to engage in the learning process.

In general, the panel of experts appreciates the various assessment methods offered in the Master programme and rates them as suitable to reach different learning outcomes. However, the experts see using so many partial examinations in each module as not competence-oriented enough. It is unnecessary to test all competencies in every module, so the experts recommend focusing on the learning objectives more precisely and reducing the examinations accordingly. Spreading the competency assessment across the different modules will also help students focus more in-depth on the content and reduce the continuous pressure to deliver. This was criticised by student representatives in the discussion with the expert panel. For example, if the module aim is programming ability, a programming project would make sense as a single examination. If the goal is to develop research skills, then a term paper and possibly a presentation is appropriate.

The three representatives of the labour market which talked to the panel of experts during the site visit were quite satisfied with the students' ability to acquire new skills but would like to see more practical skills or additional skills such as product design/design thinking - depending on the industry. The various assessment methods and field placement support the interlacing of theory and practice. A more detailed evaluation about the knowledge transfer outside the university context is challenging for the experts since the discussion with students did not include any alumnae.

The block course structure enables a precise organisation of examination without overlaps. Students receive the dates of assessment early enough and get their individual grades before taking the exam. During the discussion with the lecturers, the panel of experts got the impression that lecturers give detailed feedback on the students' performance only if students ask for an explanation of their grades. The experts find it essential to give specific feedback after each assessment to enable a comprehensive learning process for the students. The assessment regulations are accessible to students and the discussion with student representatives showed that they know the rules about the repetition of exams and the procedure for student appeals.

With regards to PhD students, the panel of experts observe an additional burden on students through the examination of competencies at the Master's level. The expert panel understands that there is the need of bridging courses for some PhD students but does not consider it useful for PhD students to take Master's modules, as these are not tailored to the needs of PhD students. Moreover, they have to absolve the same exams like Master's students. Furthermore, the supervisors do not communicate the timings of the relevant modules early enough to the PhD students. PhD students reported that they have issues with planning their time for research without knowing when exactly the modules take place. The panel of experts recommends to reconsider the requirement to take Master's courses and its organization.

The supervisors inform their students about the minimum requirements to complete the PhD programme but the experts see space for improvement on the website to make it more transparent to the public. It must be communicated transparently which different modes of completing the programme (i.e. monograph versus cumulative dissertation, thesis defence or viva voce, questions concerning the recognition of individual achievements, status of publications, timescale for publications) are applied.

According to the PhD supervisors, they inform external examiners about the examination methods and requirements. The students are all supervised by 2 to 4 professors, but the panel of experts cannot make any statements about the cooperation between the supervisors.

The panel of experts rates it as suitable that the PhD students report every six months to their supervisors on their progress. Further forms of supervision are not applied consistently since the lecturers were not sure about how much time they are supposed to spend with their PhD students. According to the discussions with lecturers and students, they meet weekly or at least twice per month. The PhD students reported that one week is sometimes too short for them to reach progress. The panel of experts see the need for the University to define the frequency of supervision hours clearly and transparently. Furthermore, it is unclear if the supervision like it is organized yet, guarantees high-quality publications. The experts got the impression that either the pressure to publish is too great or the instructions are inadequate. This problem should be addressed by the internal QA system.

b) Reconsideration evaluation in 2025:

A combination of practical examinations and theoretical written examinations is used to target a further competence orientation (typically 60%/40%).

Results and feedback (e.g. from intermediate exams) are provided continuously after the assessments.

The study programme has been updated according to the requirements. Also, credits have been added for the research methodology course.

The university communicates transparently to the students of the PhD programme which different modes of completing the programme (i.e. monograph versus cumulative dissertation, thesis defence or viva voce, questions concerning the recognition of individual achievements, status of publications, timescale for publications) are applied.

A staff workload policy reflects the quantitative extent of supervision. Nevertheless, the university must demonstrate how this will be communicated transparently to the students (**finding 4**).

Conclusion

The criterion is partially fulfilled.

4. Student admission, progression, recognition and certification / Legal status, admission and certification

Master degree

Consistently applied, pre-defined, and published regulations are in place which cover student admission, progression, recognition, and certification.

[ESG 1.4]

Doctoral degree

The institution is entitled to award a doctorate.

Consistently applied, pre-defined, and published regulations are in place which cover student admission, progression, recognition, and certification.

[ESG 1.4]

Description

Admission requirements for the Master's programmes are based on student's prior educational background. Requirements listed in the SER are (i) a Bachelor Degree with Second Class Honours Upper Division in an ICT or Electrical & Electronics area, (ii) a Bachelor Degree in Computer Engineering in combination with at least two years of professional experience in the field. The latter group will have to take at least four pre-requisite courses in operating systems, microcontrollers, power systems, and digital signal processing.

The progress of the students in the Master programme is monitored by the assessments and by evaluations and students feedback.

Admission requirements for the PhD programmes include (i) a minimum of Second Class Upper Division or equivalent at a Bachelor's level, (ii) an MSc degree in a relevant discipline, (iii) a research concept including a research problem, methods, expected outcomes, and application to priority domains such as agriculture, energy, or health. The admission guidelines provided in the General Academic Regulations for Postgraduate Studies state that candidates must apply through the UR's online portal. Applications are processed by the relevant subcommittees of the Postgraduate Studies Committee and a list of recommended candidates will be sent to a team of experts for approval. Admission letters are issued by the Directorate of the University.

The course works in the PhD programme shall be completed within a period of the first three semesters. The core disciplinary graduate modules are chosen like presented in the table in chapter 1 of this report. Minor Generic Skills modules which are Research Methodology and the English Academic Writing and Communication have to be chosen and are recorded in the Student Learning Plan. Students are required to complete the module, including all elements of assessment and examination based on the timeline. Both categories of modules are non-credited and shall be assessed on a PASS/FAIL basis. The supervision of the PhD thesis also discusses the progress of the research thesis during the regular meeting with the student.

Recognition of degrees obtained at other HEIs is said to depend on the equivalence of the degree as confirmed by the Higher Education Council (HEC) in Rwanda. The Centre Council is said to check prior studies and to verify their equivalence before granting admission.

With regards to mobility, the UR states that students have the opportunity to participate in exchange programmes at partner universities. Memorandum of Understandings that include passages on student exchange have been signed with the State University of Zanzibar, the University of Malawi, the SRM Institute of Science and Technology Chennai (India), the Indian Institute of Technology Kharagpur, the Abdus Salam International Centre for Theoretical Physics (Italy), and Rochester University.

Experts' evaluation

a) Evaluation in 2022

Formal requirements for admission are clearly stated and it meets specific requirements. A committee is set up by the University of Rwanda to look after that. The panel of experts appreciates that clear criteria are set up based on professional experience and ability that guides the admission process. It is unclear for the panel of experts if applicants are informed about funding opportunities right from the beginning or if third party funds are offered to them. ACEIoT collects data on the admission procedures of past cohorts.

The panel of experts was informed in the discussion with the students that the teaching staff is accessible for questions and problems. Very good feedback was given by the incoming student highlighting the personal support by the ACEIoT.

Due to the pandemic situation student exchange was on hold. For (international) exchange, only shorter internships are available, no longer-lasting exchange programmes for studying abroad are implemented at the moment. It is recommended by the panel of experts to consider a more structures exchange with universities abroad (like provided by ERASMUS programme in Europe) and that learning agreements with the cooperation partners are signed so that the students benefit from a structured exchange with recognition. To foster international exchange also a transparent system of conversion of credits from the host university has to be applied, so that students can compare it with the national credit system of Rwanda easily. The same applies to the grade conversion. Elements of the Lisbon Recognition Convention can also be implemented in the regulations of recognition at the university so that student exchange is supported. University of Rwanda should assure that a semester exchange is organised in such a way that the students can complete it without losing time (compliance with the standard period of study). If necessary, it is recommended to create specific cooperation where the required courses are comparable. The university have started creating formal learning and short courses with other institutions but they need to expand on it for revenue generation.

Additional courses are advised by the committee and are compulsory for the student to take before they graduate from the PhD programme. As explained above, the panel of experts evaluate a PhD programme in which courses on Master's level are obligatory critically. The discipline-oriented courses should be electives. Moreover, the experts recommend that for the obligatory course of research methodology credits should be given.

The University is legally entitled to award PhD degree. A certificate of graduation is handed to the students as well as a transcript of records. To create a higher transparency for internal and external stakeholders it is recommended to also offer a document, which explains the Higher Education System as well as the university profile and allows external to better understand which competencies have been gained during the studies. This could be a kind of "Diploma Supplement" like in use in the European Higher Education Area.

b) Reconsideration evaluation in 2025:

Several international cooperation agreements have been signed, as well as first exchanges been conducted for a more structured exchange with universities abroad.

The documentation of the university show that a diploma supplement will be provided for students.

Conclusion

The criterion is fulfilled.

5. Teaching staff / Academic level of supervisory staff

Master degree

The composition (quantity, qualifications, professional and international experience, etc.) of the staff is appropriate for the achievement of the intended learning outcomes.

Staff involved with teaching is qualified and competent to do so.

Transparent procedures are in place for the recruitment and development of staff.

[ESG 1.5]

Doctoral degree

The composition (quantity, qualifications, professional and international experience, etc.) of the staff is appropriate for the achievement of the intended learning outcomes.

Staff involved with teaching is qualified and competent to do so.

Transparent procedures are in place for the recruitment and development of staff.

[ESG 1.5]

Description

The recruitment policy of University of Rwanda follows a defined procedure, starting with a call for application outlining the requirements and teaching experience needed, shortlisting and interviews. External supervisors are requested to hand in their CVs which will be assessed for the adequacy for the programme requirements.

Following the information given in the SER and the annexes, the teaching staff for the programmes consists of local professors and visiting professors. The total composition consists of 16 local staff members coming from University of Rwanda (all PhD holders) and 16 visiting professors coming from different European, African or Japanese universities. Most of the teaching staff of the University of Rwanda is member of other departments and up to a certain extend also involved in teaching and research at ACEIoT. Therefore, there is (nearly) no academic staff fully responsible for the Center of Excellence. The university states that main supervisors should have at least hold a PhD and have the rank of a senior lecturer. All staff members are required to involve their current research topics into teaching and involve especially PhD students into their research activities.

The didactical and supervision quality enhancement of staff is subject within the collaboration projects of UR together with the Inter-University Council for East African Universities (IUCEA) and the University of Linköping (Sweden). Discipline-related enhancement opportunities are offered to staff on a regular basis. The SER outlines that every staff member is required to have at least two professional training activities per year. It is said that especially during Covid-19 a major focus was on blended teaching and use of simulations for practical courses.

Experts' evaluation

a) Evaluation in 2022

The University of Rwanda pointed out during the site visit that staff is supported in its development. It is unclear if there is a concept for staff development in place which also addresses administrative and support staff.

In general, a wide support of students by mid-level / post-doctoral teaching staff members is provided in addition to the full / assistant professors. This should provide a basis for up-to-date and student-centred teaching. Because ACEIoT has no own staff members, some difficulties show to have impact on the programmes. Because staff teaches in different programmes, the staff supervision times in ACE' programmes are only in ranges as low as 2-6 hours per week at 43 weeks per year, possible supervision is limited (even in the block-course concept). In addition, the responsibilities are distributed too wide, as not a single person has sufficient resources and responsibilities to consolidate and coordinate the programme, thus, for every teaching staff member, the teaching is on the level of a very low hours part-time job. Nonetheless, the motivation of the teaching staff and the effort to support the students is appreciated by the panel of experts. Therefore, a restructuring is required, e.g. by appointing professors with full-time or significant part-time assignments, to increase cohesion and provide gain for the programmes. Further, the staff qualifications should be verified to meet the high academic demand, especially in the PhD programme. The allocation of all staff members should be clear and transparently described.

The ACEIoT does its best to also include external supervisors and guest lecturers in teaching activities and student support, which is also appreciated by the students. Still, this effort cannot substitute the lack of full and responsible staff members.

Due to the combination of both conditions, the coordination of the programme and the resulting supervision of students is limited, which also arose within the feedback round during the site visit. For the PhD programme, for example, the quality of the resulting publications (that were mentioned as references in the discussions) were subpar, with basic levels of quality and scientific principles not met. This should be taught, moderated and filtered by qualified advisors with international academic experience.

b) Reconsideration evaluation in 2025

Based on the statement of the university, the count of associate professors has been extended to 4. Also, Ph.D. supervisors are required to be senior lecturers, which should typically be a sufficient level.

Conclusion

The criterion is fulfilled.

6. Learning resources and student support / Support and research environment

Master degree

Appropriate facilities and resources are available for learning and teaching activities.

Guidance and support is available for students which includes advice on achieving a successful completion of their studies.

[ESG 1.6]

Doctoral degree

Guidance and support are available for students which include advice on achieving a successful completion of their studies.

Appropriate facilities and resources are available for learning and research activities.

[ESG 1.6]

Description

Learning Resources

According to the SER, the faculties and departments have to submit a detailed plan for each financial year, which is used by University of Rwanda to make an overall plan in order to allocate the budget to the respective departments. The ACEIoT has its own budget which is managed on centre level with support of the Single Project Implementation Unit (SPIU). The Centre has annual work plans and allocates budgets according to the needs, such as teaching and learning activities, required laboratory material, infrastructure or others.

The programmes at ACEIoT have access to the existing resources of the College of Science and Technology campuses. This includes two smart classrooms with computers, one videoconference room, two special laboratories for wireless intelligent sensor and embedded computing systems). On non-discipline related resources, students have access to coffee rooms, and two PhD student resident rooms. ACEIoT has also access to the College's library which offer both hard cover and online resources.

Student Support Services

The ACEIoT supports students during the academic year at various stages. At the beginning of the academic year ACEIoT states that new students are introduced to the ACE and university's system during an introductory week. Following the SER, the international students are provided with special attention especially when it comes to travelling to Rwanda and the preparation. Furthermore, the grievance team which can be contacted over the homepage deals with complaints and appeals of all sorts.

In general, students are advised by a resident staff of the university. According to the SER, teaching staff offers consultation hours on a regular basis through face-to-face meeting, e-mails or online. In addition, special consultation can be given to students with special needs, international students, exchange students.

For projects and final theses, the programmes assign supervisors to the students, which meet regularly with the students. It is stated that this happens either face-to-face or in blended mode. Following the guidelines on the university level, the meeting will be documented, and they strive to provide students feedback on the current status of their project/theses. Based on these meetings a student research progress will be composed, signed by the supervisor, and submitted to the postgraduate coordinator to follow the student's progress.

As outlined in the SER, PhD students receive support through weekly meeting with the supervisory team (consisting of one main supervisor and two co supervisors), who ensures the feasibility of the research project or the timeline. PhD students of ACEIoT are involved in larger research project, which might be part of their own research, this will be monitored by the coordinator of the so-called Single Project Implementation unit (SPIU).

In terms of exchange of PhD students, the SER outlines that students are obliged to go abroad for a period of two months. At the moment of submission of the SER students have conducted exchanges at the International Centre for Theoretical Physics (ICTP/Italy), SRM Institute of Science and Technology (India), Indian Institute of Technology Khargpur (India) and others.

It is stated in the SER that all students are sponsored by the World Bank, which is differentiated in various categories of scholarships (including living allowances, tuition fee waivers). In addition, students can receive a scholarship from other resources, e.g., the Inter-University Council East Africa (IUCEA).

Experts' evaluation

a) Evaluation in 2022

According to the discussion with the students and lecturers, students get the information of assessment at the beginning of each module. The module descriptions are accessible on the website and include the expected workload. The experts see the need to define the individual assessment more transparent and the intended learning outcomes more specific in the module description (see above). The block course structure enables an easy course organisation without overlaps.

Students mainly work on their own laptops but the university also offers computer workplaces. The panel of experts rates the laboratories as sufficient to reach the intended learning outcomes since they contain the needed equipment for basic prototyping. The panel of experts encourages the university to further invest in resources to reach a level above the standard (like: working database, ACM and IEEE online libraries for good research output. Additional IoT development boards and communication modules, suitable and more complex sensors, pre-configured workstation PCs, etc.). The students have good access to the laboratories and staff is present all day long for support. The facilities have enough space for all IoT students.

The experts positively highlight the many offered scholarships and the offered accommodation for students with a child. The experts panel would like to encourage the university to establish more scholarships, infrastructure and flexibility (e.g. kindergarten, part-time study programme, etc.) for students with a child to increase the number of female students.

During the site visit, the experts' panel identified accessibility issues of online libraries, e.g., to IEEE, even though the library website stated a subscription. Furthermore, the students were not aware of such subscriptions since they rely on their own IEEE student membership. The number of printed books relevant to the students of IoT is poor. The panel of experts sees the urgent requirement to improve the online library availability and enable access to databases beyond IEEE as it is essential for a research-intended university to produce high-quality publications.

The students reported positive about the advisory services. Especially international students felt well supported at their arrival in Kigali. The pandemic situation was a hinderance for mobility, but the experts would like encourage ACEIoT to support its Master's students with the same motivation since currently none of the students go for a study abroad. The aspect of staff and student mobility should be evaluated within some years.

The panel of experts like the intended compulsory international research exchange of the PhD students but see more space for improvement in participating in conferences and workshops. During the discussion with students, the students also declared their interest in such participation.

On the basis of the written documents and the discussion with the students it seems that introductory offers are available for new and potential students. Moreover, students can make use out of the connections of ACEIoT with the labour market which is also relevant for finding practical placements.

There is no doubt that students are supported by the teaching staff in gaining skills necessary for a future research career. Still, it is unclear how this happens on a structural level as being part an integrated part of the programme. In the opinion of the experts, the university has to offer more career-oriented skills for PhD students like the acquisition of funding, writing for PhD students, etc. The PhD students get guidance in academic teaching by assisting another lecturer. In what way students' supervisors support their PhD students with publications is not transparent to the experts but they see the need for more support since a few of the publications were not of high quality.

As mentioned before, the programmes at ACE IoT are relatively new, so that it is difficult to predict the success of the graduates on the labour market. But especially because there are not so many PhD programmes in Rwanda, the University of Rwanda should take the chance of this World Bank project and produce excellent graduates. The panel of experts would like to see that ACEIoT would take all effort possible to create a research environment which facilitates PhD students' research and foster the qualifications necessary for a future research career. This does not exclude that the students are also informed about alternative career paths outside academia.

b) Reconsideration evaluation in 2025

In addition to newly acquired books, IEEE access as a digital resource has been provided, which is crucial as a literature source in engineering sciences.

Funding acquisition is based on personal mentoring; success examples have been provided. Other career-oriented skills are not covered in the statement by the university. Beyond funding acquisition, further career-relevant skills and topics should be covered, as mentioned in the finding (**Finding 5**).

Conclusion

The criterion is fulfilled.

7. Information / Public information

Master degree

Impartial and objective, up-to-date information regarding the programme and its qualifications is published regularly. This published information is appropriate for and available to relevant stakeholders.

[ESG 1.8]

Doctoral degree

Impartial and objective, up-to-date information regarding the programme and its qualifications is published regularly. This published information is appropriate for and available to relevant stakeholders.

[ESG 1.8]

Description

As stated in the SER for the ACEIoT the main source of information for external stakeholders is the homepage. Information is published about the ACEIoT in general, the staff and scientific committee members, current research and master theses, the centre reports (including budget plans), and partners from academia and the labour market. The information on the homepage includes introductory video material about the ACE and the current version of the centre's brochure outlining the focus areas of the respective programmes.

Experts' evaluation

a) Evaluation in 2022

The panel of experts has difficulties to access the website because for unknown reasons it was not working from some external networks. It seems that the content is not completely up-to date and that information on details of the programmes are lacking. It is recommended to introduce processes which guarantee that the information on the website is regularly updated and accessible.

The experts got the impression that on different levels of the university many activities take place but that the information is not known to other levels. Therefore, information dissemination is a big issue. Because the management of information is crucial for spreading your services, ACEIoT should consider which channel should be addressed for spreading which information. Perhaps, responsibility for this topic should be defined within the staff members or staff should be developed or employed to take over this task. Also, the activities in social media should be improved significantly.

b) Reconsideration evaluation in 2025:

Specific personnel now ensures dissemination and information provision. Social media presence and center website are extended which is sufficient to fulfil the finding.

Conclusion

The criterion is fulfilled.

IV. Recommendation of the panel of experts

The panel of experts recommends accrediting the study programme “Internet of Things” (Master) with specializations in “Embedded Computing Systems” and “Wireless Intelligent Sensor Networking” offered by the University of Rwanda with conditions.

The panel of experts recommends accrediting the study programme “Internet of Things” (PhD) with specializations in “Embedded Computing Systems” and “Wireless Intelligent Sensor Networking” offered by the University of Rwanda with conditions.

Findings:

1. Several learning outcomes which are generic and overlapping, should further distinguished and better tailored to the very specific courses.
2. The inter-module application of different tools should be specified and harmonised for all courses in the Masters’ curriculum.
3. All documents that show the level of publications as well as the number of papers need to be updated.
4. The university must demonstrate how the information regarding the supervision hours is communicated transparently to the students.
5. Beyond funding acquisition, further career-relevant skills and topics should be covered by the university.