ISSN: 1857-9000, EISSN: 1857-9019

GEOINFORMATICS EDUCATION IN UNIVERSITY OF PRISHTINA

Milaim SYLKA[1], Ymer KUKA[2], and Bashkim IDRIZI[3] [I*]

UDC: 378.016:[528:004.6(497.115)

SUMMARY

The department of geodesy is one of the five departments of the faculty of civil engineering and architecture, which within a period of 15 years has managed to establish study programs at both Bachelor and Master. The main purpose of these programs is to produce professional graduated staff who will be knowledgeable in both geodetic measurement techniques, Cartography, Geoinformatics and Remote Sensing. Within this period, these programs have been through some changes, actually in use is the third curriculum of 2015 year re-accreditation, while next academik year 2020/21 will start with curricula of 2019 re-accreditation with some minor changes. Compared to the previous two curricula, the curicula of 2015 has been developed in collaboration with Tempus project simultaneously has developed the curriculum in master level. While the second master's curriculum has come into use in this academic year. With this paper we will attempt to elaborate on the Geoinformatics aspect within the four curriculas in bachelor level and two curriculas at the master level of Geodesy within the Department of Geodesy.

Key words: Education, Geoinformatic, Geodesy, Curricula, University of Prishtina.

INTRODUCTION

Over the last decade, geoinfromatics has become a term that has been used by different groups of geospatials and geoscientific fields. Geoinformatics is a new discipline, thanks to the development of science and technology that has made it a field that integrates various fields of geoscience and those dealing with geospatial information such as Geodesy, Information Technology, GIS,

[*I] **University of Prishtina "Hasan Prishtina"** www.uni-pr.edu
Faculty of Civil Engineering and Architecture https://fna.uni-pr.edu
GeodesyDepartmenthttps://fna.uni-pr.edu/Departamentet/Departamenti01/Gjeodezi.aspx
[1] MSc. Milaim SYLKA milaim.sylka@uni-pr.edu;
[2] Dr. Ymer KUKA ymer.kuka@uni-pr.edu;
[3] Assoc.Prof.Dr. Bashkim IDRIZI bashkim.idrizi@uni-pr.edu

Cartography, GNSS, Geology, Photogrammetry, Agri-culture, Forestry and other soil sciences. Geoinformatics can be thought of as the field in which geoscientists and computer scientists are working together to develop tools to address a range of complex scientific questions, using advanced spatial information technologies and integrated analysis (Keller, 2011).

Kosovo as a new country has faced the need to build new professional staff in the higher education with the inclusion of geoinformatics field. Students, before the year 99 studies in these fields have mainly taken place in the university centers of the former Yugoslavia as well as in the other European countries. The most visited centers in the former Yugoslavia were university in Zagreb, Sajarevo and Belgrade (IDRIZI, 2013). At that time in Kosovo, certain subjects in these fields were part of other programs, such as geodesy in Constructive program, Mine surveying in Geology/Minig, etc. In 2003, the first study program at the bachelor of geodesy was opened, within the Faculty of Civil Engineering and Architecture respectively the Construction Section. With the opening of the new program, the opportunity to build the new professional staff in the field of geoinformatic has also been opened. During these 15 years of existence of this program there have been several changes in curricula, academic development and training, development of laboratory (equipment and software), infrastructure, etc. In addition, the program has collaborated with other international Universities, such as the ERASMU + program and the implementation of other funding projects such as Tempus, where a Master degree curriculum has also been developed.

A BRIEF OVERVIEW OF THE DEVELOPMENT OF THE GEODESY DEPARTMENT

The University of Pristina is the most important educational, scientific and cultural institution in Kosova. For more than forty years it was the sole carrier of higher education. The University of Prishtina is relatively new – forty-three years old, but the path of its development was dynamic, and the educational, scientific and artistic activities were rich and with great results, with undeniable and historic weight. The first institution of higher education in Kosova was the Higher Pedagogical School in Prishtina (1958). Till year 1970, several independent high institutions have been established, such as higher schools and faculties, in total 13 higher education institutions (IDRIZI, 2013).

As part of the Technical High School in Pristina in 1961, the section of Civil Engineering was also erected, which is also known as the foundation of today's faculty. In 1965, this technical high school was transformed into the Technical Faculty with the Construction Section. This trend of transformation

continues even in 1988, which is divided into three faculties: Faculty of Civil Engineering and Agriculture, Faculty of Electrical and Faculty of Machinery (UP, 2005). Within the Faculty of Civil Engineering and Architecture two sections were developed: that of Construction and Architecture. In the academic year 2002/2003 the faculty began work on the directives of the Bologna Declaration, first at the Bachelor level and then at the master's degree in 2005 (Prishtinës). Based on market economy requirements in the academic year 2003/2004, FNA for the first time opened the Geodesy study program for the Bachelor level. Following the opening of the geodesy program, the FNA had an organization and the programs shown as the figure below.

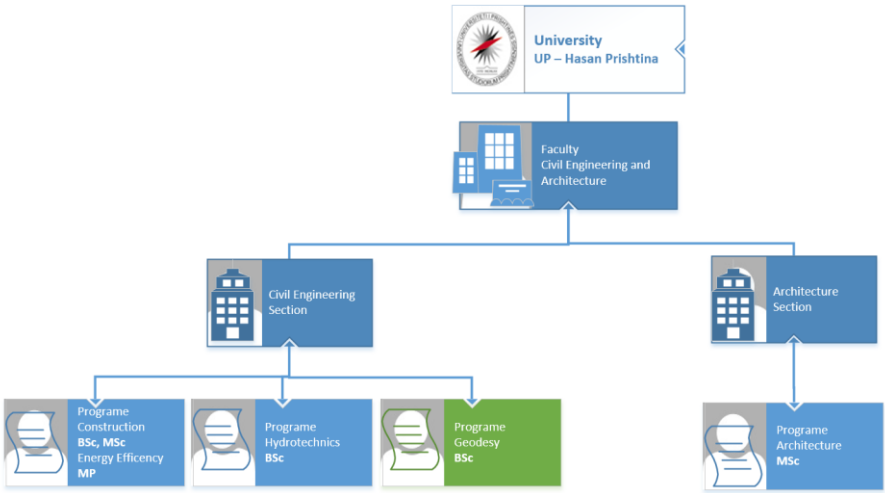

Figure 1 Organogram of Faculty of Civil Engineering and Architecture/ programs

In December 2017, the council of the Faculty of Civil Engineering and Architecture re-organizes within the faculty, and decides on the establishment of the Department of Geodesy by delegating responsibilities, obligations and duties in an equivalent form to other departments such as that of Civil Engineering, Architecture, Hydro-techniques and Environmental Engineering. The new organogram and programs are presented as follows.

Since its formation, the mission of the Faculty of Civil Engineering and Architecture (FNA) has been focused on the teaching and learning, continuous scientific research, researches from academic staff in the service of the academia and society at large as well as developing professional staff with market requirements. The goal of the FNA is to provide quality based on the highest standards in the field of teaching and learning to support the needs and expectations of students, other stakeholders and the whole society. The politics and procedures developed and adopted for all programs by the Faculty

of Civil Engineering and Architecture are applicable to geodesy programs as well.

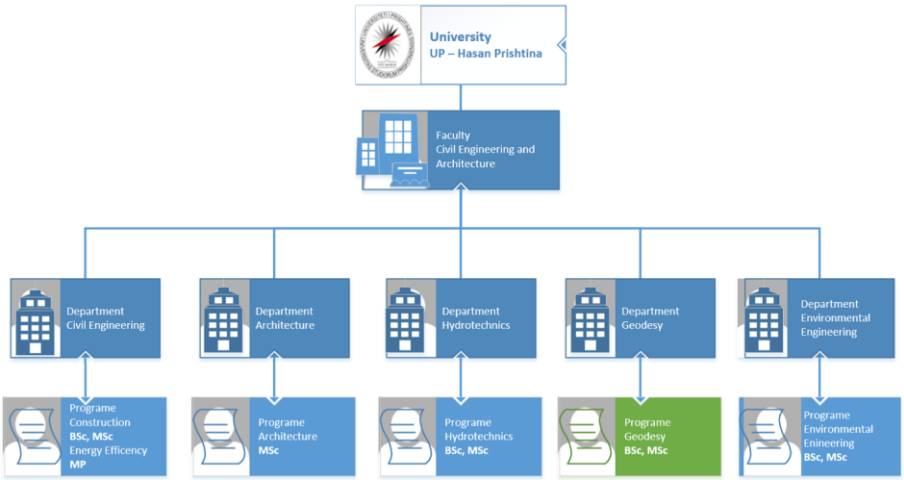

Figure 2 Organogram of Faculty of Civil Engineering and Architecture after re-organistation 2017 / programs

The teaching staff engaged in geodesy programs is qualified and highly experienced. As such, they are committed to achieving the highest results in research and teaching. Currently, the geodesy study program includes a total of thirteen teachers with academic qualification Professor. According to the academic titles, five are full professors, two are associate professors, five are assistant professors, two lecturers. This program includes teachers who are trained in teaching methods as well as student assessment practices in the context of learning. It is important to note that the Department of Geodesy has made progress in advancing academic staff. During 2018 a full-time assistant professor was employed; with a rate also engaged a professor for lectures. From the CVs of the academic staff, it is clear that during the last three years they have published scientific papers in international journals, which are part of well-known databases such as Scopus. In terms of international cooperation, the academic staff regularly participates in various research at international universities and conferences. Part of the academic staff are also four assistants, who are currently completing their PhD studies, two of which are expected to be completed by 2019.

In the context of enhancing the quality of teaching, the Department of Geodesy has also been active in projects with international universities, thus benefiting from the TEMPUS project to create a new Master's degree program in Geodesy. This project was developed in partnership with four international universities: Kungliga Tekniska Högskolan-KTH, Sweden; University of West Hungary, Hungary; Vilnius Gediminas Technical University, Lithuania;

Aristotle University of Thessaloniki, Greece; as well as five local partners: Ministry of Agriculture, Forestry and Rural Development; Ministry of Education, Science and Technology; Kosovo Cadastral Agency; Istog Municipality; "Geo & Land" with a duration of three years 2013-2016 (MPG). Upon completion of the project the geodesy program has benefited from a new master's program in Geodesy (its curriculum will be discussed below); creation of a new geodesy laboratory with geodetic equipment; computer equipment; training in partner university from project on topics such as: GIS and its application held-Hungary, digital mapping and image processing-Greece, Cadastral-Lithuania Information System, modern geodetic concepts Pristina; development of new teaching materials; implementation of new pedagogical methods.

In terms of technical equipment, the department is enriched with the latest technology equipment provided through the TEMPUS project. The geoinformatic cabinet is equipped with the latest commercial and open source software and the geodesy laboratory with the necessary equipment.

Computer equipment under the new cabinet:

- Server, WorkStations, Laptop, Printer, Ploter, Scanner, Projector
- Commercial software: ArcGIS, Erdas IMAGINE, Trimble Bussines Center.
- Free and open source software: QGIS, GrassGIS, Geogebra, FreeCAD, uDig, Geoserver, Mapserver, Geonode, OpenLayers, Heron GIS, MapStore, GeoTools, GDAL / OGR, PostgreSQL / PostGIS, Orfeo ToolBox, Monteverdi, OSSIM, gsal , RTKLIB, JAG3D, etc.

Geodetic equipment within the geodesy laboratory:

- GPS receivers (Base & Rover & Controller) with all supporting equipment,
- Total Robotic Station with all supporting equipment,
- Total Manual Stations with all supporting equipment,
- Digital Levels with all supporting equipment,
- Manual levels with all supporting equipment,
- As well as various accessories for the needs for geodetic exercises.

So far about 400 students have graduated from the bachelor Geodesy program and one in the master's degree.

At the end of 2018, the Department of Geodesy has renovated new spaces, which are necessary and sufficient for the progress of student teaching, research and learning.

GEOINFORMATICS EDUCATION IN DEPARTAMENT OF GEODESY

It is important to understand the strategic importance of geoinformation for geodesy as well as for other areas (such as spatial planning, environmental monitoring, forestry, agriculture management, etc) that also use maps and geospatial information. Among the main objectives of the program is to educate younger generations, which will greatly help improve the geosciences sector in Kosovo, as well as improve the level of application of geo-information in Kosovo, which can significantly improve state of management of information related to spatial planning, infrastructure, environment, agriculture, forestry etc.

From the above discussion we see that the department and study program in Geodesy within FNA is a relatively new branch of studies. However, it is important that for these 15 years of operation, the program has already laid the groundwork for sustainability but also the desire to adapt to the growth of market-oriented curricula. Analyzing the curricula of this program, we find that there are constant changes in it. Currently, the third curriculum is in use for bachelor level which came into force from the re-accreditation of 2015. As in the first two curricula, as in the last and next curricula the total credits foreseen are 180 ECTS credits of 3 years duration (6 semesters), but in 2015 are including 12 ETCS for diploma thesis while from next curicula 2020 will be 9 ETCS for diploma thesis. This opens the way for the creation of a Master's Degree Curriculum in Geodesy, is a 120 ETCS Master's Degree Program in a duration of 2 years (4 semesters) including a Master diploma thesis with 30 ETCS (MSc, UP). Below we present the four curricula(2003-2020) for bachelor level and two for master level (2015-2019) for all subjects along with details about the number of hours for lectures, exercises, Obligatory (O) or Elective (E) status, semester and ETCS credits.

Table 1 Content of the first year bachelor curricula with changes over the years

	curricula 2003					curricula 2007				curricula 2015				curricula 2019 (start 2020/21)			
	No	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS
Semestre 1	1	Mathematics 1	O	3+3	7	Linear algebra and analytical geometry	O	2+2	6	Linear algebra and analytical geometry	O	2+2	6	Linear algebra with the analytical geometry	O	2+2	6
	2	Descriptive geometry 1	O	2+2	5	Programming	O	2+2	6	Programming	O	2+2	6	Programming	O	2+2	6
	3	Physics 1	O	2+2	5	Physics	E	2+2	6	Physics including Mechanics	O	2+2	6	Physics with Mechanics	O	2+2	6
	4	Practical geodesy 1	O	3+3	7	Geodetic instruments and introduction into geodesy	O	2+2	6	Database technology	O	2+2	6	Basic Geoinformatics	O	2+2	6
	5	Foreign language	O	2+0	2	Foreign language	E	2+0	6	Foreign Language	O	2+0	6	Foreign language	O	2+0	3
	6	Sociology	E	2+0	4	Basics of geoinformatics and informatics	O	2+2	6	Ecology	O	2+0	3	Geodetic Instruments	O	2+0	3
	7	Computer and informatics	E	2+2	4												
Semestre 2	1	Mathematics 2	O	3+3	7	Computer geometry	O	2+2	6	Calculating geometry	O	2+2	6	Calculating geometry	O	2+2	6
	2	Descriptive geometry 2	O	2+2	5	Mathematical analyses	O	2+2	6	Mathematical Analysis	O	3+3	9	Mathematical analysis	O	3+3	9
	3	Practical geodesy 2	O	3+3	6	Land surveying	O	2+2	6	Land surveying	O	2+2	6	Basic of geodesy	O	2+2	6
	4	Geodetic drawing	O	1+2	4	Analyses and processing of geodetic measurements	O	2+2	6	Basic Geoinformatics	O	2+2	6	Database Technology	O	2+2	6
	5	Foreign language	O	2+0	2	Field measurements	E	2+2	6	CAD in surveying	E	1+1	3	CAD application in geodesy	E	2+2	3
	6	Physics 2	E	2+2	4	Basics of property rights for land registration	E	2+2	6	Basic Geotechnical engineering	E	2+1	3	Object Oriented Modelling and Programming	E	2+2	3
	7	Geoinformatics 1	E	2+2	4	Spherical trigonometry	E	2+2	6					Introduction to geotechnics	E	2+1	3
	8	Academic writing with communication	E	0+2	2												

Table 2 Content of the second year bachelor curricula with changes over the years

	curricula 2003					curricula 2007				curricula 2015				curricula 2019 (start 2020/21)			
	No	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS
Semestre 3	1	Mathematics 3	O	3+3	7	Databases	O	3+2	7	Geodesy	O	3+3	9	Land surveying	O	2+2	6
	2	Geoinformatics 2	O	2+2	5	Differential geometry	O	2+2	6	Cadastre	O	2+2	6	Cadastre	O	2+2	6
	3	Practical geodesy 3	O	3+3	6	Cadastre	O	2+2	6	Engineering surveying	O	2+2	6	Differential Geometry	O	2+2	6
	4	Topography	O	2+2	5	Geodetic plans	O	2+2	6	Adjustment methods	O	2+2	6	Adjustment methods	O	2+2	6
	5	Foreign language	O	2+0	2	Topography	E	2+1	5	Topographic mapping	E	2+1	3	Compilation of plans and maps	E	2+2	3
	6	Mechanics	E	2+2	5	Practical work with geodetic instruments	E	2+2	5	Registration and Valuation of Immoveable Property	E	2+2	3	Registration and valuation of real estate	E	2+1	3
	7	Geodetic software's	E	2+2	5									The use of geoinformation	E	2+2	3
Semestre 4	1	Geoinformatics 3	O	2+2	5	Cartography	O	2+2	6	Differential geometry	O	2+2	6	Basic of Engineering Geodesy	O	2+2	6
	2	Practical geodesy 4	O	3+3	7	Geodetic reference frames	O	2+2	6	Photogrammetry	O	2+2	6	Photogrammetry	O	2+2	6
	3	Theory of errors with adjustments 1	O	3+3	6	Photogrammetry	O	2+2	6	Cartography	O	2+2	6	Cartography	O	2+2	6
	4	Real estate cadastre 1	O	2+2	5	Utilization of geoinformations	O	2+2	6	Field surveying, practice with geodetic equipment	O	2+2	6	Field surveying with geodetic equipment	O	2+2	6
	5	Foreign language	O	2+0	2	Geoinformation modeling	O	2+2	6	Water management	E	2+1	3	Water management	E	2+1	3
	6	Mathematics 4	E	3+3	5					Spatial planning	E	2+1	3	Spatial Planning	E	2+1	3
	7	Geodetic astronomy 1	E	2+2	5					Feasibility study for GIS	E	2+1	3	Basic of GIS	E	2+2	6

Table 3 Content of the third year bachelor curricula with changes over the years

	curricula 2003					curricula 2007				curricula 2015				curricula 2019 (start 2020/21)			
	No	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS
Semestre 5	1	Theory of errors 2	O	2+2	6	Satellite positioning	O	2+2	6	Satellite Positioning	O	2+2	6	Satellite positioning	O	2+2	6
	2	Engineering geodesy 1	O	3+3	7	Engineering geodetic basis	O	2+2	6	Remote sensing	O	2+2	6	Remote sensing	O	2+2	6
	3	Real estate cadastre 2	O	2+2	6	Remote sensing	O	2+2	6	Geodetic control networks	O	2+2	6	Geodetic networks	O	2+2	6
	4	State survey	O	2+2	6	Land development	O	2+2	6	GIS applications	O	2+2	6	GIS Application	O	2+2	6
	5	Photogrammetry	O	2+2	6	Land information systems	E	2+2	6	LIS	E	2+1	3	Land Information System	E	2+2	3
	6	Land development 1	E	2+2	6	Topographic cartography	E	2+2	6	LAW	E	2+1	3	Legislation and geodesy provision	E	2+0	3
	7	Road projects	E	2+2	6					GNSS in positioning and navigation	E	2+2	3	GNSS application in positioning and navigation	E	2+1	3
	8	Geodetic astronomy 2	E	2+2	5												
Semestre 6	1	Engineering geodesy 2	O	3+3	7	Engineering geodesy	O	2+2	6	Land Regulation	O	2+2	6	Land regulation	O	2+2	6
	2	State survey 2	O	2+2	6	State survey	O	2+2	6	Land Management	O	2+2	6	Land management	O	2+2	6
	3	Land development 2	O	2+2	6	Map projections	O	2+2	6	Professional ethic	E	2+0	3	Mathematical cartography	O	2+2	6
	4	Geodesy and environment protection	E	2+2	6	Geoinformation infrastructure	E	2+2	4	Management	E	2+0	3	Three Dimensional Laser Scanning in Geodesy and Geoinformatics	E	2+2	3
	5	Physical planning and urbanistics	E	2+1	5	Web cartography	E	2+2	4	Web Cartography	E	2+2	3	Management in geodesy and geoinformatics	E	2+2	3
	6	Introduction into GIS	E	2+2	6	Basics of geodetic astronomy	E	2+2	4	**DIPLOMA THESIS**	**O**		**12**	WEB Cartograph	E	2+2	3
	7	**DIPLOMA THESIS**	**O**		**0**	Hydrographic survey	E	2+2	4					**DIPLOMA THESIS**	**O**		**9**
	8					**DIPLOMA THESIS**	**O**		**0**								

Table 4 Content of the Master curricula

	curricula MSC 2015 -First year								curricula MSC 2019 -First year							
	No	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS	Subject	Status	L+E	ETCS
Semestre 1 / Semestre 2	1	Geodetic reference systems	O	2+2	6	Global Navigation Satellite Systems	O	2+2	6	Geodetic reference systems	O	2+2	6	Global Navigation Satellite Systems	O	2+2	6
	2	Geospatial databases and data integration	O	2+2	6	Advanced theory of errors	O	2+2	6	Geospatial databases and data integration	O	2+2	6	Advanced theory of errors	O	2+2	6
	3	Geovisualization	O	2+2	6	Geoinformation Science & Spatial analysis	O	2+2	6	Geovisualization	O	2+2	6	Geoinformation Science & Spatial analysis	O	2+2	6
	4	Research methodology	O	2+1	3	Cadastre Information Systems	O	2+2	6	Spatial data Infrastructure	O	2+2	6	Cadastre Information Systems	O	2+0	3
	5	Applied mathematics	E	2+2	6	Land market economy	E	2+2	6	Applied Mathematics	E	2+2	6	Land Market Economy	E	2+2	6
	6	Foreign language	E	2+0	3	Real Estate	E	2+2	6	Foreign language	E	2+0	3	GIS in Environment	E	2+1	3
	7	Advanced digital photogrammetry	E	2+2	6	Virtual Cartographic Modeling	E	2+2	6	Advanced digital photogrammetry	E	2+1	3	Virtual Cartographic Modeling	E	2+2	6
	curricula MSC 2015 - Second year								curricula MSC 2019 -Second year							
	No	Subject	Status	L+E	ETCS												
Semestre 3 / Semestre 4	1	Physical geodesy	O	2+2	6	**DIPLOMA THESIS**	**O**		**30**	Physical Geodesy	O	2+2	6	**DIPLOMA THESIS**	**O**		**30**
	2	Advanced Image Processing and Remote Sensing	O	2+2	6					Advanced Image Processing and Remote Sensing	O	2+2	6				
	3	Engineering surveying (mine included)	O	2+2	6					Engineering surveying (mine included)	O	2+2	6				
	4	Project management	O	2+2	6					GI Project management	O	2+0	3				
	5	Web GIS	E	2+2	6					Web GIS	E	2+2	6				
	6	Agriculture Information Systems	E	2+2	6					Agriculture Information Systems	E	2+2	3				
	7									Decision Support System	E	2+0	3				

In general, in all four geodesy study curricula in bachelor, the fields of geodesy, cartography, geoinformatics, GNSS, cadaster, remote sensing, etc. are intertwined.

The first curriculum (FNA, 2003) had a total of 44 possible subjects, 28 of them with obigatory status with 150 ETCS, while for the other 30 ETCS students had the option to select some of the 16 subjects. In the first curriculum, the field of geoinformatics includes subjects in the same field:

geoinformatics I, geoinformatics II, geoinformatics III, GIS Introduction and related subjects such as Computer and Informatics, Geodetic Drawing, Software in Geodesy, Digital Cadastre. It implies that 8 possible subjects with 37 (~ 20%) ETCS, where 3 subjects with 14 (~ 8%) ETCS of them having mandatory status. From this it can be seen that the first curriculum enabled the student to make a choice of subjects and a desire to orient themselves.

The second curriculum (FNA, 2007) that was implemented from the 2007/2008 academic year had a total of 37 possible subjects, 24 of them with 145 ETCS were obligatory, while for the other 35 ETCS the student had the option to choose. Within the field of geoinformatics or similar in this curriculum we find the following: Geoinformatics basics and informatics, Programming, Databases, Geoinformation modeling, Remote sensing, Land information system, Geoinformation infrastructure, Web Cartography. It implies that 8 possible subjects with 45 (~ 25%) ETCS, where 5 subjects with 31 (~ 17%) ETCS of them having obligatory status. This shows that the second curriculum gave more ETCS in the field of geoinformatics but less opportunity for the student to select them.

The third curriculum (FNA, 2015) which was implemented by the academic year 2015/2016 had a total of 37 possible subjects, of which 27 with 147 ETCS were obligatory, thus extending the diploma thesis with 12 ETCS, while for another 21 ETCS students there was space to choose from 13 subjects. Subjects related to the field of geoinformatics within this curriculum include: Geoinformatics basics, programming, database technology, CAD in geodesy, Feasibility study for GIS, Remote Sensing, GIS Applications, Land Information System and Web Cartography. It implies that 9 possible subjects with 42 (~ 23%) ETCS, where 5 subjects with 30 (~ 17%) ETCS of them having obligatory status. It can be seen from this that the third curriculum gave less ETCS to more potential subjects in the field of geoinformatics.

The fourth curriculum (FNA, 2019) which after re-accreditation in 2019, will start implemention into academic year 2020/21, will have a total of 40 possible subjects, of which 25 of them with 147 ETCS are Obligatory, thus extending the diploma thesis with 9 ETCS, while for another 21 ETCS the student have space to choose from 15 subjects. Subjects related to the field of geoinformatics within this curriculum we find are identical to those of the 2015 curriculum but adding some additional electives such as: Object Oriented Modeling and Programming, the use of geoinformation, basic GIS and geodesy and Geoinformatics. It implies that 13 possible subjects with 54 (30%) ETCS, where 4 subjects with 24 (~ 13%) ETCS of them having obligatory status. From this it can be seen that the fourth course gives more subjects and possible credit to the field of geoinformatics.

In comparing these curriculums in the cartographic aspect that Prof. Idrizi points out in his work, the second curriculum has contained more cartographic

subjects, such map projections, topographic cartography, web cartography, geodetic maps, general cartography, geoinformation modeling etc. According to him, the second curricula gave the study a wide range of knowledge, for practical work in the cartographic sector, and to deal with many types of mapping projects.

CONCLUSIONS

From the aspect of curriculum change it can be seen that the Geodesy program is tilting in the direction of the geoinformatics field with about ~ 25% of the subject credits related to it. Add to that the subjects directly related to fields such as Cartography, Geodesy, Photogrammetry, Cadaster, Agriculture, Forestry, etc. it implies that this program are related to geoinformatics. Based on the analysis of curiculums we can conclude that in the near future the geodesy program can be re-viewed and recognized as a Geoinformatics or Geomatics program. This path is also traced to the development of the latest geoscience trends in terms of big geospatial data, Artificial Intelligence AI, Machine Learning, and Deep Learning, where more space should be given to programming related subjects.
In conclusion, we can say that the current curriculum in the field of geoinformatics is an important part of training students in applying and managing geospatial information.

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