Study framework for DBBT master in Western Balkans countries

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***Abstract*—The paper presents the academic framework for curricula development in the Erasmus+ project on Master Studies in Digital Broadcasting and Broadband Technologies (DBBT) at Electronics and Electrical schools of six Western Balkans universities and with the participation of three European Union universities.**

***Index Terms* — Digital Broadcasting and Broadband Technologies; Erasmus plus; higher education.**

I. Introduction

THIS paper presents a comparative analysis of postgraduate study programmes in the fields of DBBT from EU and ICT based study programmes from Western Balkans (WB) countries. This report includes an overview of WB and EU study programmes with a list of recommended topics and directions for implementation of new DBBT postgraduate curricula in WB countries to complement electronics and electrical engineering topics.

II. Related study programmes of WB partners

This chapter includes presentation of the engineering and ICT related study programmes in the WB partner countries: Serbia, Kosovo under UN resolution 1244, and Bosnia and Hercegovina. The main curricula topics are discussed as well as their appropriateness for post graduate studies in the DBBT domain [1]. The main outcomes of this analysis are presented in this section.

As mentioned, most of them are based on electrical engineering and ICT related topics, with some differences between them. Regardless of the differences, most study programmes present a sound basis for the DBBT master study programmes, with the exception of one study programme, which will need to incorporate more basic DBBT related topics in order to comply with the given goal. The presented study programmes are similar to the extent that they can be presented by the following domains, which are related to DBBT domain: Basics or Fundamentals of Electrical Engineering, Telecommunications, Multimedia, Software Development and, though to a lesser extent, the Electronics/Automatics domain. The specifics of each university's study programme are presented in individual subchapters.

As in many of the domains, the DBBT domain also experienced an evolution in terms of software and application supported terminal equipment, better known in technological terminology like "SmartTV", "AndroidTV", "IPTV", to name just a few. This evolution allows for development of interactive applications in the DBBT domain, therefore knowledge of application/software development is needed and appreciated by the employers of DBBT experts. Many of the analysed WB study programmes already include a significant part of these topics, while others address them to a lesser extent.

Other topics related to the DBBT domain are addressed as well such as Social Sciences, Management, etc., which are not necessarily essential for the DBBT domain, but can add value to the students' knowledge.

The existing study programmes of the WB partner countries are analysed from the perspective of the DBBT related topics and covered subjects with a preliminary identification of topics needed to implement the DBBT study programmes. Most of the analysed WB study programs are based on Electronics and Electrical engineering subjects as well as ICT, with added subjects, which contribute to differences between them. The analysed study programmes and their specifics are described in more detail in the following sections

A. University of Priština in Kosovska Mitrovica

At the University of Priština in Kosovska Mitrovica (UPKM) the existing study programmes cover two main fields: the Electrotechnics and Telecommunication on one hand, and Computing and Information on the other. These represent a good basis for DBBT study programmes as they cover a number of fields related to DBBT in the sense that they represent either the basics or the complementary topics, which are related to DBBT domain. The study programmes' topics at UPKM match the above mentioned domains as follows:

1. Theoretical Basics: Mathematical Topics, Physics, Fundamentals of Electrical Engineering, Digital Signal Processing, Image Processing, etc.
2. Telecommunications: Networking, Broadband, Basics of Telecommunications, Optical Communications, Fundamentals of Television, Satellite Systems, etc.
3. Multimedia: Multimedia Systems, Audio-Visual Systems, Cameras, etc.
4. Electronics/Automatics: Electronics, Circuits, Automatics, etc.
5. Software Engineering: Software Development, Algorithms and Data Structures, Software Design, etc.

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These topics represent a sound basis for a Master study programme in DBBT as many of the existing topics are more or less related to it. The courses most relevant to the field of DBBT are Telecommunications, Digital Signal Processing, Antennas and EM Wave Propagation, Digital Communications, Radio Communications, Broadband Communication Networks, Multimedia Systems, Audio Systems and Fundamentals of TV. Somewhat less relevant for the DBBT is the domain of Electronics/Automatics topics, even though these topics are somewhat related and can be found a useful basis for DBBT master studies in terms of electronic basis of the audio-visual equipment used in studios, etc.

B. University of Banja Luka

At the University of Banja Luka (UNIBL) the existing four year ICT study programmes cover three main fields: Electronics and Telecommunication, Computing and Informatics, and Power and Industrial Systems/Power Engineering and Automation. Out of these three, the relevant ones for the DBBT study programmes are Electronics and Telecommunications as well as Computing and Informatics. Similarly to other study programmes of WB partners they also represent a good basis for DBBT study programmes as they cover a number of fields related to DBBT. The study programmes' topics at UNIBL match the above mentioned domains as follows:

1. Theoretical basics: Mathematical topics, Physics, Fundamentals of Electrical Engineering, Digital Signal Processing, etc.
2. Telecommunications: Telecommunication Systems, Telecommunications Networks, Antennas and Radio Waves, Information Theory and Coding, Digital Communications, Radio Relay Communications, etc.
3. Multimedia: Multimedia Telecommunications, Multimedia Signals and Systems, Acoustics and Audio-Technics, etc.
4. Electronics/Automatics: Digital Electronics, Microwave Technics, etc.
5. Software Engineering: Programming.

The structure of the study programmes is such that the first year of studies covers the fundamentals through basic courses such as Mathematics, Physics, Fundamentals of Electrical Engineering and Programming. These topics represent a sound basis for DBBT master as many of the existing topics are more or less related to it. The most relevant courses are Telecommunications, Digital Signal Processing, Antennas and Radio Waves, Multimedia Communications, Multimedia Signals and Systems, Acoustics and Audio Technics.

C. Singidunum University

At the Singidunum University the existing four year ICT study programme is based on Software Engineering and Development as well as on Electrotechnical Engineering. This differentiates it from other study programmes in a way that Singidunum offers more software/programming oriented topics than any other of the WB project partners. Nevertheless, many topics and subjects represent the basis for DBBT master study programmes. The study programmes' topics at Singidunum match the above mentioned domains as follows:

1. Theoretical basics: Mathematical Topics, Physics, Electrical Engineering, Digital Signal Processing, etc.
2. Telecommunications: Telecommunications, Signals and Systems, Internet Technologies and Web Services with additional elective courses such as Mobile Communication Systems, Telecommunications Access Networks, etc.
3. Multimedia: multimedia is not that strongly represented as in other study programmes. There is one related course named the Multimedia Systems.
4. Electronics/Automatics: not very strongly represented, some courses like Automated Management Systems and Power Converters do exist.
5. Software engineering: this field is strongly represented through a number of topics such as Application Software, Programming, Concurrent and Distributed Systems, Fundamentals of Computer Technology, Cloud Computing, Operating Systems, Databases, Security, Mobile Applications Development, Internet Programming, etc.

The structure of the study programmes is such that the first year of studies covers the fundamentals through basic courses such as Mathematics, Physics, Fundamentals of Electrical Engineering and Programming. Later on there are many elective topics, which the students can choose from.

This study programme also represents a sound basis for a Master study programme in DBBT as many of the existing topics are more or less related to it. The most relevant courses to the field of DBBT are Telecommunications, Digital Signal Processing, Signals and Systems, Multimedia Systems and many of the software engineering topics as digital TV domain experts need the knowledge on development of interactive applications.

D. School of Electrical and Computer Engineering of Applied Studies (VISER)

The school of Electrical and Computer Engineering of Applied Studies (VISER) offers thirteen study programmes, seven bachelor applied studies and six specialist applied studies - most of them are offered on both levels. These study programmes are Electronics and Telecommunications, Audio and Video Technologies, Electronic Business, Mechatronics, New Computer Technologies, Computer Science, New Energy Technologies, and Security of Information and Communication Systems. Two of these study programmes are much related to the field of DBBT and as such offer a sound basis for the DBBT post-graduate studies: Electronics and Telecommunications, and Audio and Video Technologies. The former is related to DBBT from the engineering perspective while the latter is oriented towards the production of the digital TV related content (audio and video content). Other study programmes are not that related and will not be discussed in this work.

Two study programmes' topics at VISER match the above mentioned domains as the following.

The Electronics and Telecommunications study programme:

1. Theoretical basics: mathematical topics and electrical engineering, digital signal processing, etc.

2. Telecommunications: Telecommunications, Digital Transmission Systems, Communication Networks, Mobile Communications, Telecommunication Services and Technologies etc.

3. Multimedia: multimedia topics are not that strongly represented, but there is a very relevant and DBBT related course named the Digital TV.

4. Electronics/Automatics: it is strongly represented through courses like Analogue Electronics, Digital Electronics, Audio Electronics, Automatic Control, Microcontrollers, Programmable Logic Circuits, etc.

5. Software engineering: this field is well represented, through a number of related topics such as Application Software, Fundamentals of Programming, Computer Architecture and Organisation, etc.

Audio and Video Technologies study programme:

1. Theoretical basics: Mathematical Engineering and Electrical Engineering are mandatory topics.

2. Telecommunications: not very strongly represented, but the students get the basics through courses like the Fundamentals of IT, Fundamentals of TV, and Digital TV.

3. Multimedia: the most represented field as the entire study programme is multimedia oriented. There are a number of courses about Studio and Production Equipment, Audio Recording, Acoustics, Sound Design and Audio Production, Video Production, Multimedia Production, Computer Graphics and Animation, Digital Multimedia and Digital TV, etc.

4. Electronics/Automatics: not very strongly represented, there is a course named Electronics.

5. Software Engineering: understandably not significant in the study programme, with the exception of a course the Application Software.

It should be noted that this study programme includes also other interesting topics, such as Mass Media, Marketing, Social Networks etc., which are not directly related to the DBBT domain, but are indirectly connected to it.

These topics also represent a sound basis for a post-graduate study programme in DBBT, one from the production perspective, while the other from the engineering perspective. The most relevant courses to the field of DBBT are Telecommunications, Digital TV, Audio Production, Video Production, Multimedia Production, etc.

E. University of Bihać

At the University of Bihać (UNBI), the relevant and analysed study programme is from the Faculty of Technical Engineering. The main domain is Electrotechnical Engineering with a significant inclusion of Software Engineering topics. Again, the study programmes' topics at UNBI match the above mentioned domains as follows:

1. Theoretical basics: Mathematical Topics, Physics, Electrical Engineering, Digital Signal Processing, etc.

2. Telecommunications: not much emphasis but the basics are obtained through the Basics of Telecommunications, and Computer Networks.

3. Multimedia: represented through the courses of Multimedia Systems, and Computer Graphics and Animation.

4. Electronics/Automatics: Digital Electronics, Electronics, Design of Microprocessors, Automatic Control, Robotics and Automatization, etc.

5. Software engineering: a very well represented domain includes topics on Software Development, Computer Architectures, Databases, Computer Security, Operating Systems, Web Design, etc.

These topics represent a sound basis for DBBT master as many of the existing topics are more or less related to it. The most relevant courses to the field of DBBT are the Basics of Telecommunications, Digital Signal Processing, Multimedia Systems and Software Development topics including Web Design. Somewhat less relevant for the DBBT are Electronics/Automatics topics, even these topics are somewhat related and can be found a useful basis for DBBT master studies in terms of electronic basis of the audio-visual equipment used in studios, etc.

F. Higher technical professional school in Zvečan

The study programme of the Management in Electrical Engineering from the Higher Technical Professional School in Zvečan differs from the other study programmes in the sense that it is not so ICT/Telecommunications Engineering oriented. The study programme's main domain is Power Electrical Engineering with a significant inclusion of Managerial, Social and Business topics. It should be noted, that some basic topics are covered such as Physics, Mathematical Topics and Basics of Electrical Engineering, which do present a basis for DBBT study programmes to certain extent. The study programme is matching the DBBT related topics as follows:

1. Theoretical basics: Physics, Electrical Engineering, Engineering Mathematics.

2. Telecommunications: not covered.

3. Multimedia: not covered with the exception of the Computer Graphics course.

4. Electronics/automatics: not covered with the exception of the Electronics course.

5. Software engineering: somewhat represented through the Basics of Computer Science and the Database Course.

In order to provide basis for a DBBT based post-graduate study programme, more of the Telecommunications and Multimedia related topics are needed, which can be covered through a number of mandatory and elective courses covering the above mentioned domain on graduate and post-graduate level. These solutions will be investigated in the course of future project work.

III. Related study programmes of EU partners

The study programmes of EU partners are a complementary combination of different aspects from the DBBT domain.

A. University of Ljubljana

A typical representative of such study programmes are the ones provided by the University of Ljubljana, where the graduate and postgraduate study programme Multimedia are taking place. The DBBT domain is strongly represented through topics such as Radio and TV systems, Multimedia systems, Studio and Broadcasting, etc. These study programmes include a noticeable amount of software development oriented topics as well as other application and interaction related topics. The laboratory work provides students with hands on experience in broadcasting as well as the content (audio-video) production domain to some extent.

B. Universidad Politecnica de Madrid

A similar study programme is offered by the Universidad Politecnica de Madrid from Spain, where a Multimedia Systems and Services study programme is taking place. In this study programme the students learn about broadband as well as broadcast fundamentals of content delivery to the end users. Additional topics cover the basics of Content Production, Human Computer Interaction in case of Interactive Applications and Content Properties from the compression/processing point of view.

C. Technical school of Ostrava

Technical school of Ostrava, which is a typical Electrical Engineering and Telecommunications based study programme, offers a significant amount of theoretical basics as well as higher level topics related to multimedia and DBBT. Theoretical topics cover well both the Broadcasting aspects as well as Content Processing aspects, while the higher level courses introduce the students to more practical aspects of Multimedia Services.

D. University of Tartu

Somewhat different is the study programme from the University of Tartu, which includes basic DBBT domain topics such as Mathematical Basics, Digital Signal Processing, and Image Processing topics as well as a significant amount of Software Development etc. This study programme represents a basis for other domains such as Robotics.

All mentioned EU institutions have a lot of industry projects, which probably shapes to some extent the topics they offer and proves that the knowledge obtained is useful and needed in practise.

IV. Recommendations for the WB postgraduate DBBT study programmes

Based on the analysis of individual study programmes the general recommendations are made in this section for implementation of DBBT related study programmes in individual institutions. It should be noted that there is no such thing as “the ideal study programme in the DBBT domain”, because this domain has a number of “flavours” such as more Broadcasting and Core Engineering oriented vs. Content Production Oriented or even Application Development oriented. Additionally it should be noted that the suggested topics can be covered in different combinations of courses, therefore it makes no sense to exactly determine the contents of courses in one document, but rather define general guidelines, which should be followed in a general sense and implemented according to each institutions capabilities, local needs and resources available.

A. University of Priština at Kosovska Mitrovica

The existing study programmes cover two main fields: Electrotechnics and Telecommunication on one hand, and Computing and Information on the other. These topics do represent a sound basis for a postgraduate study programme in DBBT as many of the existing topics are more or less related to it.

Based on the analysis, the following topics/courses are recommended for inclusion in the DBBT postgraduate study programme: Audio-Video Technologies and Production, Digital TV Broadcasting Basics including Cable and Satellite Technologies, IP Networking related topics, Sound and Acoustics, Software/Application Development topics, some basic topics related to Information/Data/Content Processing.

Additional recommended topics are from the domain of Human-Computer Interaction, Intellectual Property Rights (IPR) and Regulation, Design Basics, Graphics and Animation, Research Methods, etc. It is advisable to have a larger number of elective courses, so the students can choose from them and adapt their knowledge to the desired skills.

B. University of Banja Luka

The University of Banja Luka (UNIBL) offers two DBBT related study programmes: Electronics and Telecommunications, as well as Computing and Informatics. These study programmes cover a number of fields related to DBBT.

Based on the analysis, the following topics/courses are recommended for inclusion in the DBBT postgraduate study programme: Audio-Video Technologies and Production, Digital TV Broadcasting Basics including Cable and Satellite Technologies, Digital TV engineering, Multimedia Systems, Software/Application development topics, some basic topics related to Information/Data/Content processing.

Additional optional topics are recommended from the domain of Human-Computer Interaction, Intellectual Property Rights (IPR) and Regulation, Design Basics, Graphics and Animation, Research Methods, etc. It is advisable to have a larger number of elective courses, so the students can choose from them and adapt their knowledge to the desired skills.

C. Singidunum University

The study programmes at the Singidunum University have two basic fields related to the DBBT domain. These are the Software Engineering and Development as well as Electrotechnical Engineering. Thus, Singidunum offers more software/programming oriented topics than any other of the WB project partners. Their study programmes as such are a good basis for DBBT postgraduate study programmes as both domains fit well into it.

Based on the analysis, the following is recommended for inclusion in the DBBT postgraduate study programme: Audio-Video Technologies and Production, Digital TV Broadcasting Basics including Cable and Satellite Technologies, Digital TV Engineering, Multimedia Systems.

Optionally some additional topics are recommended from the domain of Human-Computer Interaction, Intellectual Property Rights (IPR) and Regulation, Design Basics, Graphics and Animation, Research Methods, etc.

D. School of Electrical and Computer Engineering of Applied Studies

The school of Electrical and Computer Engineering of Applied Studies (VISER) offers two highly correlated study programmes in terms of their compatibility with the DBBT domain. As such, they offer a sound basis for the DBBT post-graduate studies: Electronics and Telecommunications, and Audio and Video Technologies. The former is related to DBBT from the engineering perspective while the latter is oriented towards the production of the digital TV related content (audio and video content).

The following topics/courses are recommended for inclusion in the DBBT postgraduate study programme: Advanced Topics on Audio-Video Technologies and Production, Digital TV Broadcasting Basics including Cable and Satellite Technologies, IP Networking and (Multimedia) Content Transmition related topics, Software/Application Development topics, Some basic topics related to Information/Data/Content Processing. Some optional recommended topics are from the domain of Human-Computer Interaction, Intellectual Property Rights (IPR) and Regulation, Design Basics, Graphics and Animation, Research Methods, etc.

E. University of Bihać

The analysis of the University of Bihać (UNBI) study programme has shown two domains, related to the DBBT. That is Electrotechnical Engineering as a basis, with a significant inclusion of Software Engineering topics. In this way, the University of Bihać study programmes are most similar to the Singidunum study programmes, with less Telecommunications/Networking topics and consequently the recommendations will be very similar. The following DBBT related topics/courses are recommended for UNBI postgraduate study programme: Audio-Video Technologies and Production, Digital TV Broadcasting Basics including Cable and Satellite technologies, Digital TV Engineering, IP Networking and (Multimedia) Content Transmition related topics, Multimedia Systems.

Optional recommended topics are from the domain of Human-Computer interaction, Intellectual Property Rights (IPR) and Regulation, Design Basics, Graphics and Animation, Sound and Acoustics, Research Methods, etc.

F. Higher Technical Professional School in Zvečan

The studies at the Higher Technical Professional School in Zvečan differ from the other study programmes in the sense that it is not that ICT/Telecommunications Engineering oriented. In order to provide basis for a DBBT based post-graduate study programme, more of the telecommunications and multimedia related topics are needed, which can be covered through a number of mandatory and elective courses covering the above mentioned domain on graduate and post-graduate level.

For inclusion in the DBBT postgraduate study programme the following topics/courses are recommended: Selected Mathematical Topics, Basics of Signal Transmition/Telecommunications, DVB-X Systems as Technology Overview, Multimedia Systems, Radio and TV Engineering, AV Production, Software/Application Development Basics. Optionally the topics from the domain of IP and Networking, Human-Computer Interaction, Graphics and Animation, etc. are recommended.

V. CONCLUSION

A general observation of these study programmes is that most of them are to a significant extent based on the field of Electrical Engineering. This in itself presents a solid basis for the DBBT study programmes as Electrical Engineering is a basic domain, on which many of DBBT topics are based on. Consequently, most of the WB study programmes include Mathematical topics, Physics, Basics of Electrical Engineering, Digital Signal Processing, etc. Furthermore, many of the study programmes include advanced topics like Digital Signal Processing, Telecommunications including Networks, Digital Communications, Information Theory and Coding, to name just a few. Some of the study programmes include more multimedia related topics such as Multimedia Systems, Audio-Visual Systems and in some cases also Digital TV topics. All of these are highly relevant for the DBBT domain.

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REFERENCES

[1] DBBT project: www.dbbt.pr.ac.rs.
[2] University of Pristina study programmes: www.pr.ac.rs.
[3] University of Banja Luka study programmes: www.etfbl.net.
[4] Singidunum University programmes: https://singidunum.ac.rs.
[5] VISER study programmes: viser.edu.rs.
[6] University of Bihać study programmes: unbi.ba.
[7] Higher technical professional school in Zvečan: vts-zvecan.edu.rs.
[8] Univerza v Ljubljani, eClassrom: https://ucilnica.fri.uni-lj.si
[9] Tartu Ulikool, Massive Online Open Course: www.ut.ee/en/current-students/moocs.
[10] Universidad Politecnica de Madrid: www.upm.es.
[11] VSB-Technical University of Ostrava: https://vsb.cz