



# Curriculum Review of the Master Program In Wireless Communications

## Report

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## Preface

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This report was commissioned to review the existing Master of Science program in Wireless Communications offered at the Telecommunication Engineering Department at Yarmouk University, Jordan. The review is a part of the activities of the Tempus project No. 511074 which was awarded to the university in July 2010.

The objective of the curriculum review is to examine the weaknesses and strengths of the existing Master program offered by the Department, measure its relevance to the need of local Telecommunications industry, measure its comparability with similar programs at EU institutions and draw a set of recommendations which will be used in the curriculum development phase of the project.

Through the surveys and meetings conducted by the Curriculum Review Work Group in a span of about 6 months, a review of the existing program and curriculum was realized as a report (this report) which highlights the main problems associated with the existing program per the reviewers' comments and draws a set of recommendations for improvement of the existing curricula and courses based on expert opinion collected through questionnaires.

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## Executive Summary

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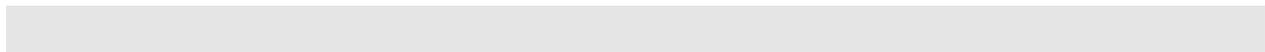
This report contains the results of the curriculum review process of the Master of Science program in Wireless Communications offered by the Telecommunications Engineering Department at Yarmouk University. This review is a part of the activities of the Tempus project No. 511074 which was awarded to the department in July 2010 and aims at reforming the existing Master program.

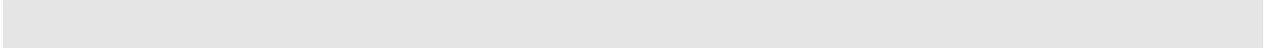
The review was based on expert opinion about the program, the contents of the curriculum as well as teaching and evaluation methods. Furthermore, the review covered other aspects such as comparability of the program to similar international programs and the relevance of the program to the needs of local and regional markets.

Review data was collected through a number of questionnaires which were completed by four target groups. The first group is academic experts with relevant experience at Jordanian universities (17 professors from 4 Jordanian universities), the second group is the telecommunications industry in Jordan (15 engineers from 7 companies), the third group is academic experts with relevant experience at EU universities (13 professors from 4 universities) and the fourth group is Master students (25 students) who were enrolled in the program in the academic year 2010/2011. Furthermore, data was also collected through a number of brain storming sessions with representatives of local industries where their feedback about the program was collected.

Through an extensive analysis of the collected data, a list of strengths and weaknesses of the program and the core courses offered was identified. On the other hand, a set of recommendations for improvement of the existing curriculum, providing comparability with similar EU programs and addressing the local market needs was developed. These recommendations include: modifying the program structure, updating the list of courses, updating course topics, introducing new study models, modifying teaching methodologies and introducing quality control measures of the program.

The main conclusion of the review is twofold: first; the existing curriculum does not address the needs of telecommunication industry with regard to type of knowledge and skills of graduates, and second, the existing curriculum is not compatible with EU educational system with regard to credit system, quality control and teaching methodologies.





# Chapter 1

## Introduction

The existing Master program offered by the Telecommunications Engineering Department at Yarmouk University was started in 2004 and offers a Master of Science degree in Wireless Communications. The program admits students who have a BSc. degree in Telecommunications Engineering or related disciplines. The program is operated by 17 faculty members most of which are PhD holders and have relevant academic experience.

The curriculum of this program was developed by the department staff in 2003 and was approved by the Jordan Ministry of Higher Education (MOHE). The curriculum development was based on a survey of similar programs in Jordan, the EU and the USA and was guided by program specifications mainly prescribed by both Ministry of Higher Education (MOHE) and the Department standards. These standards consist of a detailed list of necessary subjects, contents and associated contact hours. Hence, the curriculum development process was input driven and the curriculum was based on compulsory core curricula expressed by subject courses plus a variety of elective subjects that allow enhancement of the outcomes of the program.

One of the main shortcomings of the existing curriculum is that it was completely based on academic opinion and did not consider the needs of the local and regional telecommunications market. Furthermore, the curriculum did not have a periodic and formal procedure for obtaining or processing feedback from the industry and from its graduates.

Therefore, it was necessary to reform and update the existing curriculum in accordance with the needs of local industry as well as with the best practices in EU partner universities. The objective of the curriculum reform process is to provide a new program with up-to-date curricula which address the needs of the local market and produce graduates who are competitive and capable to take pace with dynamic labor market needs and advances in telecommunication industries.

In order to do that, the department sought funding from the EU through the Tempus Program in order to conduct curricular reform and to introduce new study tracks within the existing Master program at the Department. The Department applied for Tempus funding in March 2010 and was awarded a grant in July 2010 for a project which addresses curricular reform of its Master program. The project consists of a number of activities with the objective of reforming the existing curriculum and the introduction of new study tracks with the exiting Master program which address the needs of the local and regional telecommunications market.

The first planned activity within the project was to conduct a review of the existing curriculum by academic as well as non-academic experts from Jordan and the EU in order to point out the weaknesses and strengths of the existing program and produce guidelines on the set of improvements required in the proposed curricula. Therefore, the objective of the curriculum review process is to serve as input to the design of the new curricula, new program structure, new study models and teaching methodologies at the Department.

The remainder of this report is organized as follows: Chapter 2 presents the methodology of the curriculum review process. Chapters 3 and 4 present results of the review process and analysis of the data collected through questionnaires. Chapter 5 presents a list of recommendations drawn from review data for the improvement of the existing curriculum. Finally, Chapter 6 provides conclusions and remarks.

### ***1.1 The Telecommunications Engineering Department at YU***

The Telecommunications Engineering Department at Yarmouk University was established in 1989. Located in the city of Irbid, Jordan, the department plays a vital role in providing the market of local and regional industries with high level engineering graduates. The Department offers both B.Sc. and M.Sc. degrees in Telecommunications Engineering and Wireless Communications Engineering. These programs are operated by 17 faculty members, of which 90% are PhD holders. The offered programs attract outstanding students from Jordan and neighboring countries with an average class of around 150 per annum. Currently, there are around 850 students (800 at BSc level and 50 at MSc level) of which approximately 10% are from neighboring countries. The number of graduates has exceeded 2000 engineers who enjoyed high employability rate in Jordan and the region. As well as this, the Department has distinguished itself by offering a training program for students that provides them with a "live" experience in leading companies in Jordan and abroad, which provided strong industry ties for the faculty members as well as enhanced employment opportunity for its graduates.

### ***1.2 The Master Program in Wireless Communications***

This section presents the content of the curriculum of the Master of Science degree program offered by the Department. It inherently, therefore, includes much of the information upon which the curriculum review process is based. A brief historical overview about the Department and the contents and structure of the existing Master of Science curriculum are also presented.

The Telecommunications Engineering Department has been offering an Master of Science degree in wireless communications since 2004. The Master of Science program accepts students with a minimum of a Bachelor degree in Communication Engineering, Computer Engineering, Electronic Engineering or Electrical Engineering, in general. Currently, there are 45 students in the program, of which around 20% are from neighboring countries.

Figure 3.1 shows the structure of the existing program. The input to the program is mostly limited to recent graduates with B.Sc. degrees. Students are limited to the thesis option, where the production of a research thesis is mandatory for graduating. Students graduating from this program either join a PhD program abroad or go to work at local industries. However, obtaining a Master of Science degree does not always enhance the employability of the graduates because the existing program is not industry-oriented.

The program consists of 33 credits<sup>2</sup> including 9 credits of thesis work. The course work consists of 18 credits of core courses in addition to 6 credits of elective courses. The core courses cover various topics on wireless communications and related topics.

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<sup>2</sup> 3 credit hours means 3 hours of lecturing (contact hours) per week for 16 weeks

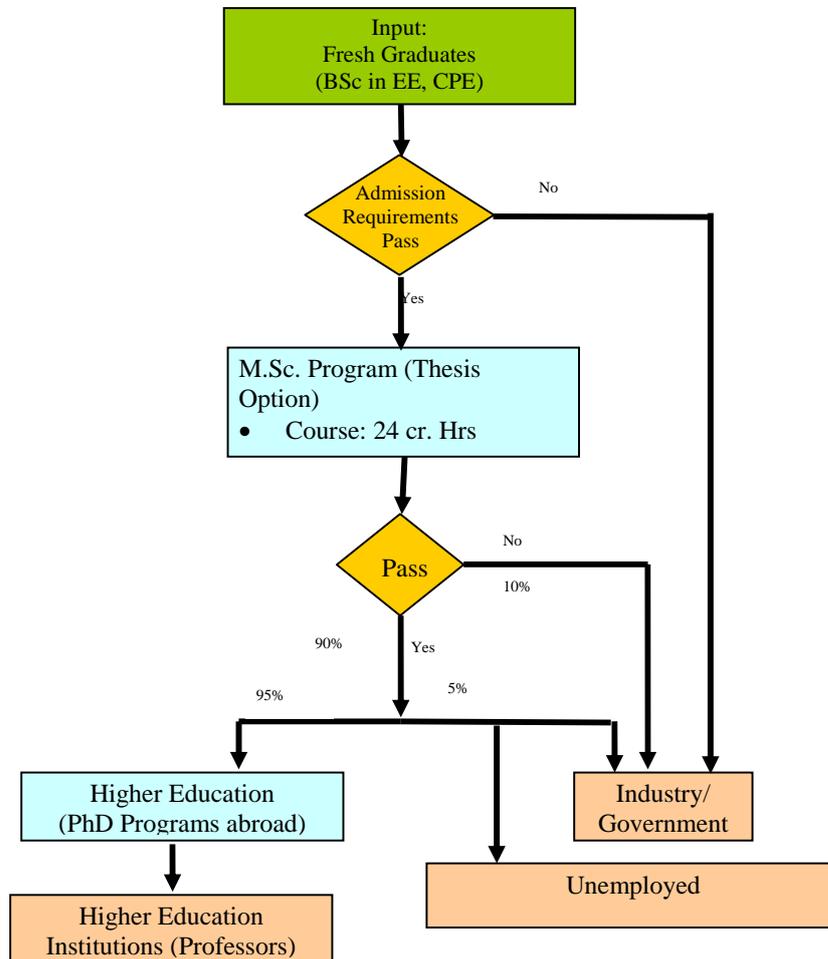


Figure 1.1: Structure of the existing Master of Science program.

### 1.2.1 Admission Requirements

The admission requirements of the program are the following:

- To have a BSc degree with at least “Good”<sup>3</sup> average in Communication Engineering, Computer Engineering, Electronic Engineering or Electrical Engineering, in general.
- To pass the English proficiency test (TOEFL) with minimum a score of 500. Applicants who do not fulfill this condition are considered for admission but have to take an English course at YU.

<sup>3</sup> A good average means a Grade Point Average (GPA) of 76% in the Jordanian standard.

### 1.2.2 Degree Requirements

Students obtain the degree of Master of Science in Wireless Communications if they fulfill the following conditions:

- Fulfill the conditions stated in the Jordanian Ministry of Higher Education (MOHE) Master level regulations, article No.2 - 2001.
- Pass the prerequisite courses determined by the Department graduate studies committee.
- Pass a total of 24 credit hours of course work with a minimum GPA of 75%.
- Pass a thesis exam which is worth 9 credit hours.

Tables 3.1 to 3.3 list the required courses in the existing program. These courses are grouped into core courses (27 credit hours including thesis) and elective courses (6 credit hours).

**Table 1.1: Core courses (27 credit hours).**

NO.	COURSE CODE	COURSE NAME	CREDIT HOURS
1	CME 610	Random Processes	3
2	CME 612	Real-Time Signal Processing	3
3	CME 614	Numerical Analysis in Electromagnetic	3
4	CME 638	Antenna, Propagations and Diversity	3
5	CME 652	Advanced Digital Communication	3
6	CME 656	Mobile Communication Systems	3
7	CME 699	Master thesis	9

**Table 1.2: Elective courses (6 credit hours).**

NO.	COURSE CODE	COURSE NAME	CREDIT HOURS
1	CME 616	Information Theory and Coding	3
2	CME 618	Detection and Estimation Theory	3
3	CME 630	Optical Networks	3
4	CME 636	Microwave Engineering	3
5	CME 640	Satellite Communication System	3
6	CME 658	Spread Spectrum Systems	3
7	CME 659	Advanced Wireless Networks	3
8	CME 691	Special Topics in communication Engineering	3
9	ELE 600	Statistical quality control	3
10	CME 653	Computer and Communication Networks	3
11	CPE 654	Embedded System Design	3
12	CPE 657	Real-Time Embedded Systems	3

### *1.3 The Tempus Project*

The main objective of the project is to modernize the existing Master of Science program in Wireless Communications at the Department and introduce new tracks that provide strong linkage to local and regional industries and contribute to providing international recognition for our programs in the area of wireless communications.

The project consists of a number of activities which will be conducted over a period of 3 years and range from review of the existing curricula to the establishment of new programs and building capacity at the Department.

The project is expected to result in reforming the existing curriculum of the Wireless Communications program and establishing two new tracks within the existing Master program; namely: Wireless Networking Technology and Telecommunications Management. The latter track is expected to offer students with a combination of technology, policy and management knowledge and will target engineering professionals who seek knowledge needed for improving their positions at their organizations. In general, the proposed tracks are expected to produce qualified/experienced engineering professionals who can compete in the local and regional labor markets.

The proposed curricula and tracks will be based on decisions on overall goals, learning objectives and intended learning outcomes. Lists of competences and abilities, knowledge and skills and subject benchmarking considerations will be described first and will serve as reference points in the curriculum development process. All newly introduced tracks will offer flexibility of switching between tracks, study models (the introduced study models are given in the next Section), options (thesis or non-thesis), and transferring/mobility of credits.

The overall objectives of the project can be summarized by the following:

1. To reform and modernize the existing Master program in Wireless Telecommunications including curricula, teaching methodologies, quality control, and to establish new up-to-date tracks in related areas.
2. To enhance student learning outcomes and skills to meet local market needs and international best practices through the building of technical capacity at YU and local partner institutions.
3. To converge our study programs with the EU educational system with regard to the Bologna process and to achieve academic and professional recognition of YU program within the EU (which will also contribute to intercultural interaction).
4. To help local project partners establish and implement their Master of Science programs in telecommunications engineering at their institutions.
5. To help the EU partners to learn more about the needs, capacities and educational approaches of the partner institutions in Jordan, and, to better understand the needs of both local and international industry.

The project is expected to result in the following outcomes/outputs:

1. Collaboration with Local Telecom Industry
2. A network of Collaboration with EU institutions
3. Professional Development of YU Academic Staff
4. A Quality Control Unit for the Master of Science programs
5. Modern Lab Equipment
6. Curriculum development of three Master program tracks: Wireless Communications, Wireless Networking Technology, and Telecommunications Network Management.

**Table 1.3 : Tempus project work packages and deliverables.**

WP No.	WP Type	Del No.	Deliverable Title
WP.1	Development	1	Review of Existing Curriculum
WP.2	Development	2	Competition Analysis
WP.2	Development	3	Demand Analysis
WP.2	Development	4	Local Market Needs
WP.3	Development	5	Visits of Jordanian Partner Academic staff to EU
WP.3	Development	6	EU Educational System Seminar
WP.4	Development	7	Professional Development of Local Academic Staff
WP.4	Development	8	Fully Prepared Curriculum Drafts
WP.4	Development	9	Fully Prepared Course Material
WP.4	Development	10	Curriculum Drafts Finalized
WP.5	Development	11	Student Selection Criteria Implemented
WP.5	Development	12	Student Evaluation Process Implemented
WP.5	Development	13	Courses Taught by Local Staff
WP.6	Quality plan	14	Quality Control Plan
WP.6	Quality plan	15	Information System for QC of Curriculum
WP.6	Quality plan	16	Progress Reports
WP.6	Quality plan	17	Budget Review
WP.7	Management	18	Memorandum of Understanding
WP.7	Management	19	Coordination Meeting
WP.7	Management	20	An Electronic Database
WP.8	Dissemination	21	An Informative Web site
WP.8	Dissemination	22	New Program Features Disseminated
WP.8	Dissemination	23	Students Recruitment
WP.9	Exploitation	24	Curriculum Approval and Accreditation
WP.9	Exploitation	25	Collaboration with Local Telecom Industry
WP.9	Exploitation	26	A network of Collaboration with EU institutions
WP.9	Exploitation	27	Quality Control Unit
WP.9	Exploitation	28	Lab Equipment

The project consists of 28 deliverables grouped under a number of work packages as shown in Table 1.3. The project work packages are classified into development, quality control, management, dissemination and exploitation and are expected to be conducted in a period of 3 years (by the end of 2013). The Development work packages include reviewing the existing curricula, conducting demand and competition surveys, training of staff and curriculum development. Quality control of the project and the new programs will be conducted through a number of activities such as the development of a QC plan and the periodic progress and financial reports. The management work package consists of a number of management activities including a memorandum of understanding between project partners, coordination meetings and the development of an electronic reporting system. The dissemination of the project will be conducted through a website and a number of dissemination activities. The sustainability of the project will be based on enhancing the capacity of the department and building a network of collaboration with a number of EU academic institutions as well as with local telecommunications industry.

## Chapter 2

# Methodology of the Review Process

The curriculum review constitutes Work Package 1 (WP1) of the Tempus project. This work package consists of only one deliverable which is the “Curriculum Review Report”. The following are the descriptions of the work package and the deliverable as stated in the project proposal:

### Description of work package

*“Review of the existing Master program with the EU consortium members and other eminent EU universities and provide critique and analysis of the problems associated with the existing programs and curricula. This includes the existing program guidelines, courses, course material, teaching methodologies and employability of graduates. The review process will result in a number of recommendations and guidelines on the set of improvements required in new curricula in the form of documents and reports. This work package will be conducted at the early stage of the project by the project partners and representatives of local industry who will provide input on the needs of the telecommunication industry in Jordan. The EU partners will be responsible for providing the vision of Bologna process in curriculum development. This review will serve as input to the design of the new program curriculum, program structure, study models and teaching methodologies.”*

### Description of the Deliverable

*“A report on the problems associated with the existing curriculum and existing program process which includes statistical data on the benefits of the program to target audience, employability of graduates, relevance of course material to the needs of industries, quality of graduates and teaching methodologies, etc.”*

## 2.1 The Curriculum Review Work Group

The Curriculum Review Work Group was formed at the first management meeting of the project and according to the project proposal. The criteria for choosing the WG members were based on their expertise and the relevance of this to the program. The role of each partner in the curriculum review work package was specified in the project proposal and is shown in Table 2.1.

The workgroup consists of 5 faculty members from the Department and one faculty member from each of the project partners. In addition, a number of Jordanian Telecommunications companies selected based on their expertise and relevance to the program were called to participate in the review process.

The workgroup was responsible for designing, distributing and collecting review questionnaires and preparing the review package which consisted of information about the existing curriculum and the review questionnaires. They were also responsible of writing this review report.

## 2.2 Target Groups

The curriculum review targeted four groups which were determined by the workgroup as the main stakeholders of the program and whose opinion would be important to assess the strengths and weaknesses of the program. The first group is the telecommunications industry in Jordan which is the main employers of the graduates. The second group is academic experts with relevant experience at Jordanian universities who are involved in similar programs and were involved in curriculum development activities at their institutions. The third group is academic experts with relevant experience at EU universities who are involved in similar programs and would provide comparisons

and contrasts between the program and similar programs at their institutions. Lastly, the fourth group is Master students (25 students) who were enrolled in the program in the academic year 2010/2011.

**Table 2.1: Role of project partners in the curriculum review work package.**

<b>PARTNER</b>	<b>ROLE</b>
<b>Lead partner: 1</b> <b>Yarmouk University – Jordan</b>	<ul style="list-style-type: none"> <li>• Preparing the documentation of the existing program.</li> <li>• Review and assessment of the existing program courses.</li> <li>• Collecting data and statistics from the target audience of the program</li> <li>• Hold review meetings</li> <li>• Publish review reports.</li> </ul>
<b>Partner number: 2</b> <b>German-Jordan University - Jordan</b>	<ul style="list-style-type: none"> <li>• Review and assessment of the existing program courses.</li> <li>• Collecting data and statistics from the target audience of the program.</li> </ul>
<b>Partner number: 3</b> <b>Hashemite University – Jordan</b>	
<b>Partner number: 4</b> <b>Dublin City University – Ireland</b>	<ul style="list-style-type: none"> <li>• Review and assessment of the existing program courses.</li> <li>• provide comparisons with EU programs</li> <li>• Provide feedback about the latest courses and teaching methodologies taught at EU.</li> </ul>
<b>Partner number: 5</b> <b>Queen Mary University of London – United Kingdom</b>	
<b>Partner number: 6</b> <b>University Polytechnic Valencia – Spain</b>	

## 2.3 Methodology

As discussed in the previous sections, the objective of the curriculum review is to determine the strengths and weaknesses as well as the set of required improvements for the existing program. For that purpose, the workgroup held a number of meetings for the purpose of developing the methodology of the review process. After a number of discussions between the workgroup members, it was decided that the review should be based on two main approaches. The first is to collect data from target groups through a number of questionnaires where target groups could complete and return and the second is direct meetings with target groups where data is collected through direct contacts and discussions in the form of minutes of meeting (MOM).

### 2.3.1 The Questionnaires

Given the different background and experience of different target groups, and the different pieces of information that each target group could offer, the workgroup, decided to conduct the curriculum review through three different questionnaires. The first questionnaire targets the academic staff of local project partners (HU and GJU), the second targets experts from the local telecom industry in Jordan, and the last targets EU partners of the project (DCU, QMUL and UPV). Furthermore, it was decided that evaluation forms for individual courses offered by the program to be prepared in order to get feedback from different target groups about the quality of individual courses and their contribution to the overall program.

**Table 2.2: Different questionnaires developed throughout the review process.**

QUESTIONNAIRE	TARGET GROUPS	ASPECTS COVERED
<b>A</b>	Academic staff of local partner universities: HU, GJU and YU	<ol style="list-style-type: none"> <li>1. Admission requirements.</li> <li>2. Course descriptions (contents, syllabi, integrity, completeness, redundancy)</li> <li>3. Course objectives</li> <li>4. Number of intakes.</li> <li>5. Quality of the program</li> <li>6. Teaching methodologies</li> <li>7. Assessment methods (Grading policy, projects, Homework)</li> <li>8. Relevance of the program to market needs</li> <li>9. Strengths, weaknesses and recommendations</li> </ol>
<b>B</b>	Leading telecommunication industries in Jordan	<ol style="list-style-type: none"> <li>1. Relevance of program courses to industrial needs</li> <li>2. Providing professional skills for industrial research</li> <li>3. Employability rate</li> <li>4. Training needs</li> <li>5. Technical issues needed for the graduates</li> <li>6. Follow up the rapid development in telecommunications industry</li> </ol>
<b>C</b>	Academic staff of EU partner universities: DCU, QMUL and UPV	<ol style="list-style-type: none"> <li>1. Admission requirements</li> <li>2. Courses description ( contents, syllabi, integrity, completeness, redundancy)</li> <li>3. Course objectives</li> <li>4. Annual intakes</li> <li>5. Quality of the program.</li> <li>6. Teaching methodologies.</li> <li>7. Assessment methods (Grading policy, projects, Homework).</li> <li>8. Relevance of the program to market needs</li> <li>9. Recognition of the program by higher education institutions in EU</li> <li>10. Program compatibility with the European three cycle system using the (ECTS)</li> </ol>
<b>Individual Course Review Forms</b>	Academic staff of local and EU partner universities	<ol style="list-style-type: none"> <li>1. Course title and prerequisites.</li> <li>2. Course description, topics and contents.</li> <li>3. Teaching tools and grading policy.</li> <li>4. Contribution to overall program.</li> <li>5. Strengths, weaknesses and recommendations.</li> </ol>

In subsequent meetings of the workgroup, the three questionnaires were designed. Although these questionnaires had significant overlap between them, each one has questions that are specific to the target group for which the questionnaire was designed. The first questionnaire (Questionnaire A) targeted YU and local partners staff (HU and GJU) and included the basic questions about the existing curriculum, such as the program contents, the program structure, teaching methods and the overall quality of the program. The second questionnaire (Questionnaire B) targeted local industry in Jordan and included questions concerning the relevance of the program to market needs, employability of graduates and other issues. The last questionnaire (Questionnaire C) targeted the academic staff of EU partner universities and included questions concerning comparability as well as compatibility of the program with EU educational system with regard to the quality of the program contents, teaching methods and quality control.

Separately, a questionnaire for individual courses (“Individual Course Review Form”) was developed. The questionnaire consisted of 15 questions which would help assess the contents, syllabus and teaching methods and the relevancy of each course to the overall program. This questionnaire targeted staff members who are experts in the field of each course in all partner universities and also

students who took these courses during the first semester of 2010/2011. Table 2.2 lists the description, target groups and aspects covered by each of the questionnaires.

The review questionnaires were sent to target groups along with other material as a review package either by email or in person. The review packages contained:

1. A description of the Tempus project.
2. A description of the existing Master of Science program including the average annual intake, current teaching methodologies, available labs and class sizes.
3. Syllabi and sample exams of the program courses (CME610, CME612, CME614, CME638, CME652, CME656, CME616, CME659).
4. Review questionnaires of the overall program
5. Review forms for individual courses.

### **2.3.2 Meetings with Local Industry**

As discussed in Chapter 1, the current Master of Science program has no formal procedure for processing feedback from the companies who hire our graduates. This is due to the fact that there is no well-developed formal interaction between industry and the University. For this reason, the workgroup members decided to contact the leading companies in the local telecommunications industry so that they could play a role in the evaluation process as well as the development of the proposed programs.

For this purpose, the workgroup decided to conduct a number of meetings with representative of local telecommunication industry in order to obtain feedback about the quality of the exiting program through brainstorming discussions. Two meetings were held at GJU campus in Amman with representatives of leading local telecommunications companies in Jordan. Major companies such as Zain, Umniah, Orange, Motorola, Jordan Engineers Association (JEA) and other small companies (a total of 12 companies) were invited to the meetings. The meetings were held right after the review package (summary of the Master of Science program, course description and Questionnaire B) was sent to them. In those meetings, the audience was presented with the project objectives, activities and the curriculum review work package. Open discussions were held on the following issues:

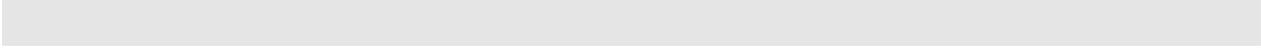
1. Relevance of the existing program to the local industry.
2. Weaknesses and strengths of the program.
3. Methods for bridging the gap between the existing program and industry.
4. The relevance of the proposed new tracks (wireless communication, wireless networks, and network management)

The meetings were also useful for discussing the best approaches for bridging the gap between the existing program and the needs of local industries. In addition, a discussion on the relevance and feasibility of the proposed new programs (wireless communications, wireless networks and network management) was held.

### **2.3.3 Data Collection and Analysis**

The questionnaires were collected by the workgroup members either via email or in person in a span of two months. The response of various target groups was different. In general, the response of industry was the slowest given their work load.

Once all the questionnaires were collected, data analysis started through subsequent meetings of the workgroup. The review data was first combined from all questionnaires where a summary of answers to each question along with its score was developed. Then, the workgroup started to summarize the strengths, weaknesses and recommendations suggested by the reviewers by drawing a consistent set of data after removing contradictory data.



## Chapter 3

### Results of the Review Process and Data Analysis-The Program

#### 3.1 Questionnaire A: Local Academic Staff

Questionnaire A consists of reviews by academic staff from local universities and was done by 17 faculty members from YU, HU, GJU and other local universities. Table 3.1 shows the outcomes of the questionnaire and Table 3.2 shows a summary of strengths and weakness suggested by the reviewers. Detailed comments of the reviewers can be found in the Appendix A.

**Table 3.1: Results of questionnaire A; local academic staff.**

NO.	QUESTION	YES
1.	Are the admission requirements for the program appropriate?	15/17
2.	Are the provided course descriptions informative and complete? Course description need to be revised	7/17
3.	Do the current offered courses give solid knowledge in wireless communications?	8/17
4.	Does the current curriculum provide the graduates with enough knowledge and skills for future competitive and changing markets?	7/17
5.	Does the reviewer see any redundancy in the program courses?	7/17
6.	Does the program provide the students with strong analytical background for continued formal education at the doctoral level?	14/17
7.	Is the current master program based on industry defined needs?	4/17
8.	Do the current master courses contribute effectively to an overall master program in wireless communications?	10/17
9.	Does the reviewer recommend any new courses to be included in the core curriculum?	14/17
10.	Does the reviewer recommend any courses to be removed from the core curriculum?	12/17
11.	Do the course syllabi need any improvement?	11/17
12.	Does the curriculum use appropriate and sufficient instructional methods?	9/17
13.	Does the reviewer recommend any additional teaching-aid methods or tools?	10/17
14.	Does the reviewer recommend any laboratory-based courses?	12/17
15.	Does the current courses evaluation method measure the intended course objectives?	9/17
16.	Is the current master degree program flexible enough to provide students with the possibility of enrolling in a joint or multiple degree programs?	10/17
17.	Is the current number of students in the master program comparable to the number of students in a similar master program offered at your institute?	NA

As clear from Table 4.1, the question about the relevance of the program to industry defined needs (Question No.7) obtained a very low score (below 50%). On the other hand, the following questions obtained very high scores:

1. Appropriateness of admission requirements (Question 1)
2. Strong background provided by the program for continued formal education at the doctoral level (Question 6).
3. The need for inclusion of new courses (Question 9).

These results assert the claim that the existing program is oriented towards higher education rather than industry needs. With regard to the need for new courses, the reviewers indicated the need for updating the list of courses to include up-to-date topics in order to keep pace with rapid development in wireless communications technologies. Furthermore, most of the reviewers indicated that the curriculum, course contents, and course syllabi need to be revised.

**Table 3.2: Summary of the recommendations obtained from Questionnaire A.**

STRENGTHS	WEAKNESSES	RECOMMENDATIONS
<ol style="list-style-type: none"> <li>1. Covers basics topics needed for pursuing further education (PhD) on wireless communications.</li> <li>2. Comprehensive/diversity</li> <li>3. Good mix of topics.</li> <li>4. Good focus on research.</li> </ol>	<ol style="list-style-type: none"> <li>1. Not relevant to industry</li> <li>2. Lack of lab work</li> <li>3. Lack of courses on technology/ wireless comm. &amp; networking</li> <li>4. Lack of courses on management</li> <li>5. Lack of simulation component in courses</li> <li>6. lack of math courses</li> <li>7. Lack of well defined program objectives and outcomes</li> <li>8. Core and elective courses lists are not up-to date.</li> </ol>	<ol style="list-style-type: none"> <li>1. Define outcomes / objectives of program</li> <li>2. Add a seminar course</li> <li>3. Use concept of collaborative course</li> <li>4. Consider market needs when program and course are redesigned</li> <li>5. Include lab work</li> <li>6. Keep theoretical contents strong for those who will join PhD programs.</li> <li>7. Remove CME 614.</li> <li>8. Add independent study course.</li> <li>9. DSP for communication</li> <li>10. Coordination and expansion of curriculum</li> <li>11. Strategic plan for faculty and new program development with input from the industry.</li> </ol>

In summary, the following are the main conclusions drawn from Questionnaire A:

1. The admission requirements are appropriate for the program.
2. The existing program provides students with strong theoretical background for pursuing PhD studies.
3. The current courses contribute effectively to a Master of Science program in wireless communications.
4. The existing curriculum does not provide graduates with enough skills for future changing market.
5. The current program is not based on industry defined needs.
6. The majority of the reviewers recommend
  - Including new laboratory-based courses in the list of the core courses in the curriculum.
  - Excluding some courses that are not directly related to wireless communications, from the core-course list.
  - Revising existing course descriptions and improving course syllabi.

#### **4. Questionnaire B: Local Industry**

Questionnaire B consists of reviews by staff of local telecommunications companies and was done by 15 engineers who hold managerial as well as technical positions at the major telecommunications companies in Jordan. The questionnaire discussed a number of issues related to relevance of the program to the market needs, employability of graduates, the need for training and professional skills of graduates.

Table 3.3 shows the outcomes of the questionnaire and Table 3.4 shows a summary of strengths, weaknesses and recommendations suggested by the reviewers. Detailed comments of the reviewers can be found in the Appendix A.

As clear from Table 5.3, 87% of the reviewers indicated that the courses in the existing program are relevant to their needs (Question No. 2). This is a surprising result as the program contents are based on theoretical content. A possible reason for this result is that the terminology used in the program and course titles indicate relevant topics to industry while the real situation is that the topics covered by these courses are dealt with from a theoretical point of view rather than application point of view. This

explanation is supported by the reviewer's response to all other questions which were all negative (score below 50%).

**Table 3.3: Results of Questionnaire B; local telecommunications companies**

NO.	QUESTION	YES
1.	Is the current master degree program based totally on theoretical teaching?	5/15
2.	Are the program courses relevant to your organization?	11/15
3.	Based on your review of the current master degree program, with regard to the current tools, facilities, and laboratories used, are they relevant to your organization?	4/15
4.	Does the current master program provide graduates with skills necessary for industrial research programs?	3/15
5.	Does the master program follow the rapid development in communication industry?	2/15
6.	Do the existing curriculum technical contents enhance the employability of graduates at your organization?	5/15
7.	In your view, what is the best approach for measuring the relevance of the program to the needs of local industry?	
8.	In your opinion, can the current program adequately prepare its graduates to be productive in your organization without further additional training?	4/15
9.	Compared with job seekers, who do not possess a master degree, can the current program improve their employability rate at your company?	4/15
10.	Does the current program prepare its graduates to take leading positions in local and regional communication industry?	1/15

As for industry needs, the reviewers indicated that, in general, the program does not meet these needs with regard to technical contents as well as professional skills. Furthermore, they indicated that the existing program does not enhance the employability of its graduates in industry nor it prepares them to take leading positions at industry. Moreover, most of the reviewers believe that the graduates need further training to be productive and contribute to the development of their telecommunication companies. This is expected since the existing program lacks courses in telecommunication management and research methodology which most reviewers indicated the need for.

In summary, the following are the main conclusions drawn from Questionnaire B:

1. The current program is theoretically oriented and does not prepare graduates to work in local and regional communication industry. Moreover, the current tools, facilities and laboratories are not relevant to local industry.
2. The current Master program does not improve the employability rate of the graduates.
3. Graduates need further additional training to be productive in industry.
4. The current program does not provide the graduates with the necessary skills for industrial research.
5. The current program does not follow the rapid development in telecommunication industry.

**Table 3.4: Summary of the recommendations obtained from Questionnaire B.**

<b>STRENGTHS</b>	<b>WEAKNESSES</b>	<b>RECOMMENDATIONS</b>
<ol style="list-style-type: none"> <li>1. Strong theoretical background</li> <li>2. Good for pursuing PhD.</li> <li>3. Includes mobile and wireless network</li> <li>4. Specific for wireless comm. not general telecom</li> </ol>	<ol style="list-style-type: none"> <li>1. Lack of practical issues relevant to local market</li> <li>2. Lack of practical labs</li> <li>3. The courses: Numerical CME 614, Real time CME 612, Random process CME 610 are not relevant to industry.</li> <li>4. No involvement of new technologies.</li> <li>5. Too much theory.</li> <li>6. Nothing related to service layer (core network).</li> <li>7. Does not focus on industrial needs in Jordan.</li> <li>8. Lack of cooperation with industry.</li> </ol>	<ol style="list-style-type: none"> <li>1. Provide field training to students</li> <li>2. students take courses in EU</li> <li>3. Combine theoretical courses and add courses with practical significance.</li> <li>4. Have adjunct professors/ instructors/ experts to teach part of courses ( collaborative teaching)</li> <li>5. More focus on programming skills.</li> <li>6. Need for a course on " introduction to wireless Telecom and networks"</li> <li>7. Add elective courses on specific elements of network. <ul style="list-style-type: none"> <li>• Digital mobile comm.</li> <li>• Network infrastructure/ comm.</li> <li>• Signaling Protocols</li> <li>• System design environment considerations</li> <li>• High Speed Mobile Communications</li> <li>• 3<sup>rd</sup> and 4<sup>th</sup> generation mobile</li> <li>• Multiservice Networks.</li> <li>• Case studies and state-of-the-art practice.</li> <li>• Optical and Broadband Networks.</li> <li>• Wireless Network Technologies</li> <li>• IP Telephony</li> <li>• Wireless Navigation Systems</li> <li>• Management of Technology and Innovation</li> <li>• Project Management</li> <li>• Research Methodology</li> <li>• Management of Network Services</li> <li>• Multimedia Communications in wireless networks.</li> </ul> </li> </ol>

### **5. Questionnaire C: EU Academic Staff**

Questionnaire C consists of reviews by the academic staff of a number of EU universities and was done by 13 faculty members from EU partner institutions (DCU, QMUL and UPV) who are involved in similar programs. The outcome of this questionnaire consists of the view of EU academic staff members with regard to the quality of the program, relevance of the program to international market needs and compatibility with the European educational system.

Table 3.5 shows the results of the review and Table 3.6 shows a summary of strengths, weaknesses and recommendations suggested by the reviewers. Detailed comments of the reviewers can be found in the Appendix.

As shown in Table 5.5, the questions that obtained the lowest score (below 50%) were about the following issues:

1. Course description (Question No. 2): only 30% of the reviewers agree that course descriptions are informative and complete.
2. Core courses (Question No. 8): only 15 % of the reviewers indicate that there is a need for some courses to be removed from the core curriculum list.

3. Assessment methods (Question No. 16): only 30% of the reviewers see that the current assessment methods for programs and courses are in line with EU standards (Q16).
4. Compliance with ECTS (Question No. 20): only 15% of the reviewers see that our current program is compliant with the ECTS system.

**Table 3.5: Results of the Questionnaire C completed by academic staff of EU partner universities.**

NO.	QUESTION	YES
1.	Are the admission requirements for the program appropriate?	9/13
5.	Are the provided course descriptions informative and complete?	4/12
6.	Do the current offered courses give solid knowledge in wireless communications?	6/12
7.	Does the current curriculum provide the graduates with enough knowledge and skills for future competitive and changing markets?	11/12
8.	Does the reviewer see any redundancy in the program courses?	7/13
9.	Do the current master courses contribute effectively to an overall master program in wireless?	12/13
10.	Does the reviewer recommend any new courses to be included in the core curriculum?	11/13
11.	Does the reviewer recommend any new courses to be removed from the core curriculum?	2/13
12.	Do the course syllabi need improvements?	10/13
13.	Does the curriculum use appropriate and sufficient instructional methods?	9/13
14.	Does the reviewer recommend any laboratory-based courses?	9/13
15.	Is the current master program recognized for admission in PhD program by higher education institutions in EU?	7/12
16.	Is the current master degree program flexible enough to provide students with the possibility of enrolling in a joint or multiple degree programs?	10/13
17.	Is the current number of students in the master program comparable to the number of students in a typical EU master program?	10/13
18.	Are the current teaching material/methods used in the master program in line with the teaching material/methods used in EU similar programs?	11/13
19.	Are the current program/course assessment methods used in our college in line with EU standards?	4/13
20.	Are the courses relevant to the needs of industry in EU?	10/13
21.	Does the current program include methods that enable a quality assurance of the graduates?	6/13
22.	Is the current master program requirements comparable with those used in EU universities?	6/13
23.	Is the current master program compliant with the European three cycle system using the (ECTS)?	2/13
24.	Is it possible for our students to transfer course credit hours into the current ECTS system?	8/13

On the other hand, the following questions obtained very high scores:

1. Curriculum for market needs (Question No. 4): 92% of the reviewers indicate that the current curriculum provides the graduates with enough knowledge and skills for future competitive and changing markets.
2. Contribution of courses to program in Wireless Communications (Question No. 6): 92% of the reviewers indicate that current courses contribute effectively to an overall Master program in Wireless Communications.
3. Similarity with EU programs (Question No. 15): 85% of the reviewers agree that the current teaching material and methods used in the program are in line with ones used in EU similar programs.

**Table 3.6: Summary of the recommendations obtained from Questionnaire C.**

STRENGTHS	WEAKNESSES	RECOMMENDATIONS
<ol style="list-style-type: none"> <li>1. High level and updated contents</li> <li>2. Wide offering of courses (broad knowledge) (comprehensiveness)</li> <li>3. Strong theoretical foundation</li> <li>4. Reasonable number of students</li> <li>5. Good choice (number) among elective courses</li> <li>6. Sufficient staff expertise</li> </ol>	<ol style="list-style-type: none"> <li>1. Need to define a " skills " table including transferrable skills</li> <li>2. Course descriptions not informative</li> <li>3. Lack of courses on management</li> <li>4. Lack of up to date technologies in course topics</li> <li>5. Prerequisites are not clearly defined</li> <li>6. Lack of lab courses</li> <li>7. ECTS equivalency not described</li> <li>8. Courses on wireless comm. are not sufficient</li> <li>9. Lack of feedback from students and industry (QA)</li> <li>10. Lack of completeness of contents in some courses</li> <li>11. Lack of description of assessment methods</li> <li>12. MSc. thesis need to contribute to overall program objectives</li> <li>13. Lack of applications and user defined issues in contents.</li> <li>14. Lack of external examination in assessment (objective assessment)</li> <li>15. Lack of programming courses</li> <li>16. Little cohesion between courses</li> <li>17. Projects exams and homework need to achieve program objectives</li> </ol>	<ol style="list-style-type: none"> <li>1. Need to make courses cohesive and complement each other</li> <li>2. Ensure that fewer courses are taught by more people-wider spectrum of staff expertise</li> <li>3. Level of practical aspects need to be increased (either as separate course or within courses)</li> <li>4. Methods of assessment must be aligned with learning outcomes of the course.</li> <li>5. Develop a mechanism for dynamic adjustment of course material.</li> <li>6. Considering feedbacks for future improvement</li> <li>7. Equivalency with ECTS and assessment</li> </ol>

The above results indicate that there is a need for revising the program structure, course descriptions and assessment methods in order to achieve compliance with the EU educational system. Furthermore, although the reviewers indicated that the courses are similar to those taught in similar programs in EU, it is clear that the existing program is not compliant with the EU system with regard to quality control where program objectives and outcomes need to be clearly defined in order to measure the efficiency of the teaching process.

In summary, the following are the main conclusions drawn from Questionnaire C:

1. Admission requirements are appropriate.
2. Course descriptions not informative and incomplete and need to be revised.
3. Lack of laboratory-based courses.
4. Courses provide graduates with strong theoretical background needed for PhD studies.
5. Courses contribute effectively to Master program in wireless communications.
6. Need for improving the course's syllabi.
7. Need for defining course objectives and outcomes.
8. The curriculum does not use appropriate instructional methods.
9. Teaching material is in line with the ones used in EU.

10. Most of the reviews indicate that the program has no quality assurance measures of the graduates.
11. Program contents are similar to those in EU universities.
12. Similarity with EU programs allows transferability of credits.
13. The existing program is not compliant with EU three cycles system (ECTS).
14. Assessment methods are different from the ones used in EU.

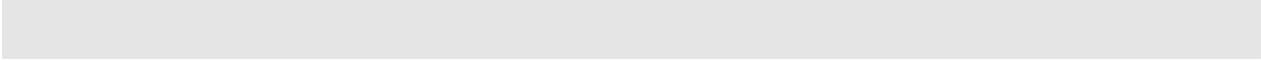
## ***6. Results from Meetings with Industry***

The following issues were raised in the meetings of the workgroup with local telecommunication companies in Jordan:

1. Lack of presentation skills among our graduates.
2. The continuation of the project for years to come, and raised some issues regarding the continuity of academic relations with EU partners and the training of the students in EU after the funded period of the project ends.
3. Our existing curriculum lacks laboratory courses which is an important ingredient that needs to be addressed in the development stage of the proposed new tracks.
4. The attendance agreed on broadening the spectrum of attendance to include all the telecommunication industry in Jordan in order to have all kind of views regarding the local industry needs to such programs and its relevance to the market.
5. The attendance agreed on to pay more effort to bridge the gap between industry and academia through the R&D centers in telecommunication companies.

The participants provided the following recommendations:

1. Include training or internship as part of the new reformed program.
2. Include projects related to technical challenges of local industry in the new proposed non-thesis option program.
3. Emphasize on the need for including communication skills and soft skills courses in the new programs.
4. The need for more specialized courses such as:
  - a. Core Network ( GSM,CDMA).
  - b. Switching intelligent communication systems.
  - c. Courses that interconnect different parts of wireless system.
  - d. " Network Mangement and Quality Control".
5. Provide the ability for offering on demand non degree specialized courses in wireless communications.
6. Provide training of professors at local telecommunications companies as a very important aspect for a successful Master program.
7. Emphasis on distance learning to allow students who are already employed to join the program.



## Chapter 4

### Results of the Review Process and Data Analysis

#### Individual Courses

Each course was reviewed by 2-3 professors and 10-15 Master students at YU. The following is a summary of these reviews which highlights the main strengths, weaknesses of each of the courses.

#### 4.1 CME 610: Random Processes

The reviewers indicated with a good percentage that the course description, syllabus, text book and references, and grading policy are all appropriate. It was also noted that the course prerequisites are appropriate.

The following comments were raised by the reviewers with regard to teaching methodologies:

1. List of references should include more up to date books.
2. More focus on simulation should be included. A course project should have a higher weight in the total course grade
3. The course should have a more visible practical component.
4. The weight of the HW assessment should be increased.

The following were indicated as the major strengths and weaknesses of the course module with regard to contents, course description and syllabus.

#### Strengths

1. Good depth and breadth of coverage in mathematical background as well as applied /advanced- related topics.
2. Well coverage; useful for spectral estimation, system identification, etc.
3. Inclusion of a variety of concepts.
4. Coverage of advanced topics on random processes
5. Course provides students with tools needed to doing research in related fields.
6. Course gives student the basic tools to understand important topic in digital and mobile communication course, for example; performance analysis of digital modulation over multipath channels.
7. Course helps student in their research work in different area of new wireless technology.
8. Provide the essential good knowledge in random processes.
9. The material covered helps students understand how to simulate communication systems in related software packages such as Matlab.
10. Students learn the theory needed for understanding advanced topics in wireless communications
11. Good coverage of the basic and important topics of the course.

### *Weaknesses*

The following items were indicated as the major Weaknesses of the course:

1. Assessment material provided (written exams) do not cover some topics e.g. "special processes" topics – perhaps those are examined through the project/ homework?
2. No learning outcomes, no information on teaching methods.
3. The content is mainly theoretical.
4. The course does not address the problem of simulation of communication systems. This can be included as a course project with higher weight than the current weight on the project.
5. The first three course topics should be covered in an undergraduate course. Queuing theory should be added to the topics as well as some applications on wireless systems.

Some reviewers indicated that such a course is typically delivered as part of the mainstream courses. Others indicated that the fundamentals covered by the course appear very complementary to a number of other courses within the curriculum. Furthermore, it was indicated that since the course does not have a practical element, its contents could be fit into other courses. A good percentage of the reviewers (8/12) indicated that this course can be discontinued and its material to be included in other courses such as CME 618, CME 612, CME 616 and CME 652 while the first few course topics should be covered in an undergraduate course.

The instructors of the course indicated that this course is very important to the program since it gives the necessary tools for other courses. However, they indicated that some issues hinder the achievement of the course objectives. These can be summarized as:

1. The lack of teaching resources (such as equipped classrooms, computer labs) makes the teaching process partially efficient.
2. The weak background of the student in simulation which makes course projects is not very effective.
3. The weak background in advanced math make it difficult to cover more advanced topics and applications and hence, it make it hard to completely achieve the objectives of the course.

Student of the course were, in general, happy with the course in general and its contents in particular. They indicated that the material is very useful for them since it constitutes the basic knowledge which they need to understand other advanced courses such as CME 652, CME656 and CME 658.

The main concern of students is the fact that the course needs a good background in Math and Signals and Systems.

Most students indicated that homework and projects are very efficient. Some recommended increasing the weight on the course project. However, they indicated that the course contents must include some practice on Matlab to enable the project to be efficiently conducted.

Some students indicated that the material is relatively abstract and they recommended inclusion of examples on wireless communications and to illustrate how random processes are useful to solve problems related to real world communication systems.

## 4.2 *CME 612: Real Time Signal Processing*

All of the reviewers agreed on that this course contribute effectively to the overall core curriculum in Wireless Communications. Although the reviewers agreed that there are many courses in the curriculum that complement this course, such as CME 656, CME 652, CME 640, CME 658, embedded system, all of them agreed that the course stands on its own and does not duplicate other courses.

A good percentage of the reviewers indicated that the course contents and teaching methods are appropriate for the course objectives. 50% of the reviewers suggested that the course topics should be covered in more depth, while others see that the course adequately covers expected topics. On the other hand, most of the reviewers criticized the course for not having a practical component (a lab).

With regard to the course title, most of the reviewers agreed that the title of the course is appropriate, with some of the reviewers suggesting the phrase "Real – Time" to be removed from the title.

With regard to course description and syllabus, all the reviewers indicated that the course syllabus includes the required minimum information. On the other hand, almost 50% of the reviewers stated that the scope of the course is of an introductory level and needs to be modified to include advance topics on the field of signal processing.

With regard to grading policy, all the reviewers indicated that it is adequate but is not well distributed. Some of the reviewers suggested that it needs to be clarified what each assessment component covers. One of the reviewers suggested that the course should be mostly practical and should be examined as such-in the form of a project rather than an exam. The main concern of most of the reviewers was that course objectives and outcomes are not assessed in the exams.

The reviewers agreed that the prerequisites of the class are appropriate, but there was a concern about other students who enters the program from other fields such as computer engineering.

Regarding teaching methodology, the reviewers indicated that it is adequate, however, some of them suggested that more practical sessions are needed, whereas, two of them were not certain.

The reviewers indicted that the following are the main strengths and weaknesses of the course:

### **Strengths:**

1. The course includes a comprehensive list of topics.
2. Good coverage of the basic and important topics of the course.

### **Weaknesses:**

1. No practical lab design component.
2. Not all objectives are examined.
3. Topics like statistical signal processing are not covered.

## 4.3 *CME 614: Numerical Analysis in Electromagnetic*

The reviewers indicated that the syllabus is informative. Course materials, teaching tools, and text book are appropriate. Also, they indicated that this course contributes effectively to the core curriculum, and they recommend inclusion of this course in the core curriculum. Moreover, they

mentioned that the course title should be "Numerical analysis in Electromagnetics", and course description has many typographical errors.

The reviewers indicated the following as the major strengths and weaknesses of the course module with regard to course title, course description, contents, and syllabus.

**Strengths:**

1. The course contributes effectively to the core curriculum.
2. The course syllabus is informative; however it should describe the project and assignments in more details.
3. The text book is an excellent choice.
4. The use of commercial software is very important for students.
5. The course covers numerical methods which are very important for Electromagnetics.
6. This course is a complement course to antennas and propagation.
7. Course covers an area of growing importance.
8. Course instructor has impressive pedigree in this area.
9. Contents are very well selected, and this course provides a comprehensive summary of topics.
10. The grading policy is suitable for this course.
11. The course is beneficial to those who will continue their Ph.D. in Electromagnetics or antennas.
12. The course covers most numerical methods used for solving EM problems.
13. Students learn different commercial software and use them to simulate and optimize different antenna designs.
14. The course improves programming skills of students.

**Weaknesses**

1. Exams for this course do not reflect the contents of the course (it is difficult to solve EM problem numerically in one or two hour exams).
2. Assessment material does not place material strongly enough in the context of EM applications.
3. There should be more detailed treatment of complex problems (i.e., fully 3D problems with staggered E and H Yee grids).
4. Exam format limits the assessment to relatively simple problems.
5. There should be more emphasis on project and assignment work.

#### **4.4 CME 616: Information Theory and Coding**

All of the reviewers agreed on that the title of the course is appropriate and that the course syllabus includes the minimum information.

A good percentage of the reviewers indicated that the course materials and teaching tools are appropriate for course objectives, but some of them criticized the course by not having practical coding concept in order for the students to gain practical experience. Also, Viterbi algorithm, convolutional code decoding and Trellis coded modulation should be included.

Most of the reviewers think the course provide an effective orientation module. Also, the text book and course materials look relevant.

Some of the reviewers suggested that the topics in the course should be covered in depth, while other sees the course is adequately covered the needs. There was concern by a reviewer that some topics appears in the catalog data, but is not covered in the course.

The reviewers agreed on that the prerequisites of the class are appropriate, but some of the reviewers suggested that CME 652 could be a prerequisite.

With regarding to grading policy of this course, all the reviewers say it is adequate, but it is not well distributed. Some of the reviewers suggested that it needs to be clarify what each assessment covers. Also, more information is required about the format of each type of assessment.

Regarding teaching methodology, the reviewers indicated that it is adequate. Some of them suggested that more practical sessions are needed, whereas, two of them were not certain.

All of the reviewers agreed that this course contribute effectively to the overall core curriculum since it is very relevant course in telecom domain. Also, some of the reviewers indicated that this course should be moved to the core list since it represents a basic block of any communication system.

***Strengths:***

1. It gives the students a complete idea of channel and source coding.
2. The course includes a comprehensive list of topics and covers coding very well.
3. Self-contained and provide excellent knowledge in coding theory.

***Weaknesses:***

1. No practical lab design component.
2. Lack of real examples describing channel/source coding (GSM, CD- audio, etc.).
3. More details are required about the assessment used.

#### ***4.5 CME 638: Antennas, Propagation and Diversity***

The reviewers indicated that the syllabus is informative, course materials, teaching tools, and text book are appropriate. Also, they indicated that this course contributes effectively to the core curriculum, and they recommend inclusion of this course in the core curriculum.

The reviewers indicated the major strengths and weaknesses of the course module with regard to course title, course description, contents, and syllabus. The strengths, weaknesses, and recommendations are listed below.

***Strengths:***

1. The text book is an excellent choice.

2. The course gives a very strong treatment of antenna fundamentals with emphasis on design principles.
3. Contents are very well selected.
4. The grading policy is suitable for this course.
5. The students learn how to design and simulate different kinds of antennas using commercial software.
6. The syllabus is informative.
7. This course is a complement course to numerical analysis in Electromagnetics.
8. This course provides a comprehensive summary of topics.

***Weaknesses:***

1. There is no mention of additional teaching techniques.
2. Pre-requisites are not adequate.
3. Propagation and diversity topics are not covered in the course.

Students were happy with this course and its contents since it offers the knowledge of antenna fundamentals and types. Also they learned how to design and simulate different kinds of antennas using commercial software.

Some students suggested adding pre-requisites for this course such as Electromagnetics and calculus (vector analysis), since these courses are needed to understand antenna analysis.

Most of the students indicated that grading policy is adequate, and that homework and projects are very efficient. Also, they indicated that the design and simulation of antennas using commercial software helped them to understand course contents.

#### ***4.6 CME 652: Advance Digital Communication***

More than 90% of the reviewers indicated that the course description, grading policy, teaching mythology, syllabus, text book are adequate. All of them indicated that the course contributes effectively to overall curriculum and they recommended the inclusion of the course in the core curriculum. The following were indicated as the major strength and weaknesses with regard to course contents, course description and syllabus:

**Strengths**

1. The course provides an appropriate Master of Science level material.
2. The course provides solid coverage of digital communication topics.
3. This course can be considered as a prerequisite for the thesis.
4. The text book and references are adequate.
5. The given material is good for other courses such as CME 656.
6. Sample examinations appear to be appropriately challenging.
7. The course contributes effectively to the overall core curriculum.

**Weaknesses**

1. Assessment material is not enough.
2. Advance topics ( OFDM, Synchronization, adaptive equalization and digital signaling over fading channel) are not covered
3. Lack of practical aspects in the methodology (No lab sessions).
4. No relevant internet resources.
5. Some overlap with CME 616.
6. The lack of use of Matlab and simulations within the course material.

The course instructor indicated that the course is very important to the program since it gives the background material for other courses. He indicated that some issues hinder the achievement of the course objectives. These can be summarized as follow:

1. The lack of teaching resources (well equipped class room, computer labs) makes the teaching process partially efficient.
2. The weak background in advanced math and basic random process theory made it too hard to cover the advance topics.
3. Both CME 610 and CME 652 are studied by the student in parallel and this increases the difficulty to achieve course objectives.
4. The weak background in Matlab simulation made course project not very efficient.

All the students indicated that the course should be taken after the completion of the prerequisite one (CME 610), as all of them studied both courses in the same semester. They had no comments on the grading policy. All of them indicated that the course contribute effectively to overall core curriculum.

**4.7 CME 656: Mobile Communication Systems**

Most of the reviewers indicated that the course description, grading policy, teaching mythology, syllabus, text book are adequate. All of them indicated that the course contributes effectively to overall curriculum. Most of them recommended the inclusion of the course in the core curriculum. The following were indicated as the major strength and weaknesses with regard to course contents, course description and syllabus:

***Strengths***

1. The course provides an appropriate Master of Science level material.
2. It provides the student with good background in wireless communication which will help the students in understanding advance topics in wireless networks.
3. High research level of the course topics. It will help the student in their thesis work.
4. The course contributes effectively to the overall core curriculum.
5. Semester project is good assessment.

***Weaknesses***

1. Course objectives are too general and too brief.

2. The listed text book and references are considered to be old, published between 1995 and 2005.
3. Assessment material is not enough, more information is needed.
4. Important topics such as multiple access techniques, OFDM, performance of IEEE 802.11 and IEEE 802 should be covered.
5. Lack of studying wireless communication systems and standards such as GSM, GPRS, UMTS and LTE.
6. Lacks of practical aspects in the methodology
7. No lab sessions
8. Some overlap with CME 616
9. The lack use of Matlab and simulation within the course material.

The internal review of the course was conducted by two reviewers from YU who taught the course. They indicated that the course that is very important to the program since it gives the background material for other courses. One of them indicated that some issues hinder the achievement of the course objectives. These can be summarized as follow:

1. The poor background of students in prerequisite topics and advance math did not help the instructor to fully cover the topics as described by the course syllabus.
2. The weak background of the student in Matlab simulation made course project not very efficient.

#### **4.8 CME 659: Advanced Wireless Networks**

Most of the reviews indicate that the course description, course material, references, prerequisites, teaching methodology and grading policies are appropriate. The majority the reviews recommend that the course title should be changed to Wireless Network. The reviews also state that this course contribute effectively to the overall Master program, and consequently should be added to the core courses. Some reviews recommend that CME 656-Mobile Communication Systems, CME 638 Antennas, Propagation and Diversity, CME 652- Advanced Digital Communications should be added to the prerequisites' list. Half of the reviews indicate that course syllabus changes are needed. Few reviews indicate that some topics or areas of expertise are not adequately covered.

The following were indicated as the major strength and weaknesses with regard to course contents, course description and syllabus:

##### ***Strengths***

1. High research level of the course topics, course evaluation procedure, semester project proposal based on analytical or simulation work.
2. Topics provide an appropriate Master level course.
3. The course includes Up-to-date technology and provides students with the sense of research and implementation of wireless concepts.
4. Course description, syllabus, course material, references, prerequisites, teaching methodology and grading policies are reasonably appropriate.

5. Most of the students expressed general satisfaction about the course, its contents and teaching methodology in particular. They indicated that this course is the most important course in the curriculum.

### *Weaknesses*

1. Course title is not appropriate.
2. Prerequisites are not specified.
3. Course topics are very general and not sufficiently specified.
4. Course topics are involved for student to study in a 3 hour credit module.
5. The course topics do not include the number of hours.
6. Major parts of the references/books are relatively out-dated (published since 2002).
7. Some information mentioned in the data catalog e.g. Bluetooth, WAP, wireless ATM are not listed in the course topics.
8. QOS performance of applications in mobile and wireless environments is missing.
9. Network simulation packages are not included into this class.
10. Final exam is not described and the weight of in-class exams (40%) considerably low compared to the semester project (30%).



## Chapter 5

### Summary of Recommendations

#### 5.1 Overall Program

Based on the above analysis, a list of recommendations was developed based on discussions among work group members and after removing inconsistencies. The concluded recommendations will be considered as an input to the curriculum reform phase (i.e., designing new curricula, restructuring the program, introducing new study models and teaching methodologies). The list of selected recommendations was grouped into three main groups. The first is a list of general recommendation on the overall program, the second is a list of modifications to the list of courses and their contents and the third is on instructional and assessment methods.

##### 5.1.1 General

1. Define the objectives and outcomes of the program and individual courses clearly.
  - a. Course objectives need to be specific & detailed describing the technical skills and knowledge to be learnt.
  - b. Re-write the course descriptors in terms of module learning outcomes (instead of “students will learn etc” say things like “the students will be able to use the method of ... to solve ...”).
  - c. Define a " Skills " table including transferrable skills.
2. There is a need for having adjunct professors/ instructors/ experts teaching part of the offered courses (i.e., collaborative teaching).
3. Ensure that fewer courses are taught by more people-wider spectrum of staff expertise will increase the level of knowledge given to student.
4. Develop a mechanism for dynamic adjustment of program contents and course material based on periodic feedbacks from stakeholders.
5. Develop a quality assurance mechanism for program and students.
6. Include projects related to technical challenges of local industry in the new proposed non-thesis option program.
7. Include communication skills and soft skills courses in the new programs.
8. Provide the ability for offering on demand non degree specialized courses in wireless communications.
9. Investigate and develop equivalency with ECTS system and assessment methods.
10. Develop standards for assessment that are in line with EU standards based on:
  - competences
  - work load
  - level
  - learning outcomes
  - profile
11. Consider developing a program that could be recognized by IET or other EU international institution professional engineer s (do a research on PE in EU IET).
12. Provide professional development of academic staff and students through industry conferences.
13. Provide the ability for offering on demand non degree specialized courses in wireless communications.

14. Provide a distance learning component to allow students who are already employed to join the program.
15. Include details about MSc. thesis in the curriculum:
  - Requirement for thesis.
  - Directions for research.
  - Process of submission proposal.
  - Publication requirements.

### 5.1.2 Course List

1. Revise all course descriptions in the curriculum and ensure that the topics covered by each course be cohesive and complement each other.
2. Remove the overlap between the following courses:
  - CME 616 and CME 652
  - CME 658 and CME 656
  - CME 658 and CME 652
3. Recommended modifications to the list of courses:
  - Remove CME 614 “Numerical Techniques in Electromagnetics”
  - Remove the course on Embedded Systems from the elective course list
  - Change the title of CME 638 from “Antenna, Propagation and Diversity” to “Antenna and Radio wave Propagation”.
  - Change the title of CME 612 from “Real time DSP to “Advanced DSP”.
  - Move the course CME 659-Wireless Networks to the list of core courses.
  - Introduce a course on “RF Engineering” in order to meet market needs
4. Based on the feedback from industry, a list of courses was recommended to be considered in the design of new curriculum. These include:
  - Introduction to Wireless Telecommunications and networks.
  - A seminar course on research methodology.
  - An Independent Study course which includes case studies and state-of-the-art practice.
  - A course on DSP for wireless communications.
  - Elective courses on specific elements of communication networks:
    - High Speed Mobile Communications.
    - Network infrastructure, communication and signaling protocols).
    - Wireless Network Technologies and Multi Service Networks.
    - IP Telephony.
    - Wireless Navigation Systems.
    - Management of Technology and Innovation/ Project Management.
    - Management of Network Services.
    - Multimedia Communications in wireless networks.
    - Signaling Protocols.
    - Network service management
    - Radio planning and optimization.
    - mobile data network
    - GPRS, EDGE
    - HSPA, LTE

- mobile core network
  - Switching
  - Signaling Protocols
5. Include the following topics in the prospective program on Telecommunication Management:
    - Competition and regulation issues in " telecom management track" also policy and management of telecom
    - Service flow and logic.
    - Soft skills: communication and negotiation, marketing, strategic thinking
    - Practical experience/ knowledge in future industries
    - Language skills – English
    - Management, project management, team management
    - Regulation and policies
    - Financial and Admin management
    - IT and computer skills
    - Lifelong learning component/skills
    - Telecom market knowledge and background
    - Organization theory and how to develop market creativity
  6. Include projects related to technical challenges of local industry in the new proposed non-thesis option program.
  7. Level of practical aspects of the offered courses need to be increased (either as separate courses or within courses). The following is a suggested list of labs:
    - Wireless Communications Lab
    - Wireless network Lab
    - DSP Lab
    - Simulation of Wireless Communications Lab
    - A general lab for MSc. Thesis practical work
  8. Include a field training component in the new programs in the form of visits to Telecommunication companies or seminars by experts from industry in relevant courses.

## **6. Instructional Methods and Course Assessment**

1. Specify objectives and outcomes in each course syllabus.
2. Specify assessment tools in each course syllabus.
3. Methods of assessment must be aligned with learning outcomes of each course.
4. Instructional Methods need to include:
  - Interactive teaching
  - Use of simulations
  - Projects/ term papers research
5. Course Syllabi need to include:
  - Measures of learning outcomes
  - Instructional methods
  - Specify type of exams
  - Specify computer usage
  - Specify chapters from which text book
  - More details on project, its outcomes and assessment.
6. Consider the Inclusion of external examination in assessment (objective assessment) if possible.

## 7. Individual Courses

The following remarks/recommendations were indicated by the reviewers to improve the core courses modules:

### *CME 610: Random Processes*

1. Changing the course title to “Random Processes in Communication Systems”
2. Include learning objectives and outcomes in the course syllabus.
3. Update the reference list in the syllabus to include up-to-date references.
4. More details in the course syllabus are required about the assessments used.
5. Include a project and homework assignments, in addition to written examinations, to give a good balance.
6. Include more practical topics such as
  - Simulation of random processes
  - System identification using random processes
  - Estimation theory.
  - Kalman predictor and filter, Wiener filters.
  - Include Applied topics, e.g. random walks, Poisson, system identifications etc. in the written examinations.
7. Add a more visible practical component to the course module. This could be done by increasing the weight on course project.
8. Increase the use of the internet resources.
9. Use computer simulations to illustrate the concepts taught in the course

### *CME 612: Real Time Signal Processing*

1. Change the course title to “Digital Signal Processing”
2. Add some MATLAB assignments to further improve the course.
3. Include lab-based practical sessions.
4. Include advanced topics such as
  - Statistical Signal Processing
  - Spectral Analysis

### *CME 614: Numerical Analysis in Electromagnetic*

1. The course title should be "Numerical analysis in Electromagnetics", and the contents should be more related to EM rather than mathematics.
2. Move this course to the list of elective courses.
3. The course syllabus should be changed to include
  - More details about practical problems and projects.
  - Electromagnetics and linear algebra as pre-requisites for this course
4. Have more emphasis on application to EM problems.
5. Have more emphasis (larger percentage weighting) on project and assignments.
6. Integrate this course more firmly with CME 638 (Antennas, propagation, and diversity).
7. Add more references.
8. Use the text book "Computational methods for Electromagnetics" by Peterson, Ray, and Metra as an alternative source.

9. Have more treatment of the source of error in numerical solutions and how they can propagate.
10. Provide students with commercial software relevant to the course topics.
11. Cover a wider range of topics to a deeper level and include more advanced topics such as:
  - Method of Moments applied to wave scattering and radiation problems
  - Greens functions, FDTD applied to 3D wave scattering problems,
  - Physical Optics
  - Geometric optics
  - Uniform Theory of Diffraction (UTD)
  - Fast Multipole Method

### ***CME 616: Information Theory and Coding***

1. Inclusion of RS/BCH codes, turbo codes and LDPC coding.
2. Add more information on teaching method in the course syllabus.
3. Tour industry projects that could be used for integrating the course with the current industry demands.
4. Add more practical sessions and assessments.
5. Provide more visible practical components in the course module.
6. Move the course to the core courses list.
7. Include advanced topics in coding such as
  - Turbo codes
  - Viterbi algorithm
  - Convolutional coding/decoding
  - Trellis coded modulation (TCM)
  - Reed Solomon codes
  - LDPC
  - Interleaving

### **CME 638 Antennas, Propagation and Diversity**

1. Change the course title to "Antenna Theory and Practice" or "Antennas and Radio Wave Propagation".
2. Add more treatment of propagation issues, as well as fading and diversity in the course topics.
3. Add more emphasis (larger percentage weighting) on project and assignments
4. Integrate this course more firmly with CME 614 (Numerical analysis in Electromagnetics).
5. Clearly identify pre-requisites for this course.
6. The contents of this course need to be more specific.
7. Add more references.
8. Include more topics such as
  - Different types of antennas used in cell phones and ultra wideband antennas
  - Plane waves in lossy and lossless media
  - Reflection from and transmission through planar boundaries (including total internal reflection)
  - Diffraction (including basic diffraction models as well as the geometric / uniform theory of diffraction)
  - Scattering

- Advanced propagation models such as those based on ray tracing, parabolic equation methods and integral equation methods
- 9. Numerical and software tools should be included in the course description and syllabus.
- 10. Pre-requisite courses should be added in the course description (such as Electromagnetics and Microwave Engineering courses).

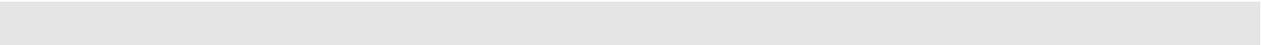
### **CME 652: Advance Digital Communication**

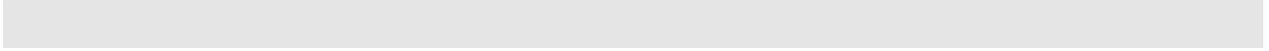
1. The word “Advanced” should be removed. The course title should be “Digital Communications” only.
2. The course CME 610: “Random Processes” should be a prerequisite for this course.
3. Have more focus on computer simulation and project work.
4. Add more details in course syllabus
5. More emphasis should be considered on practical components.
6. Include more advanced topics such as
  - Synchronization
  - Digital communication systems design with ISI
  - Partial response signaling, Adaptive equalization
  - Viterbi coding/decoding
  - Spread spectrum systems

### **CME 656: Mobile Communication Systems**

1. More orientation toward project work should be considered.
2. More focus on computer simulation.
3. The course CME 652 “Advanced Digital Communications” should be a prerequisite for this course.
4. Add material on access techniques and the impact of wireless transmission on everyday mobile applications.
5. Add more focus on simulation and project work
6. Revise the title of the course to be compatible with the course contents. Possible titles are “Mobile Communication Techniques” or “Wireless Communications”.
7. Update references and text book in order to include the latest technologies in mobile communications.
8. Include more details in course syllabus.
9. More emphasis should be considered on practical components
10. Change the sequence of the course chapters. For example multipath channel should be located in chapter 2 before propagation model and cellular concept should be located after chapter 5.
11. Include more advanced topics
  - Smart antennas
  - Interference compensation and signal separation in multiuser systems
  - Micro- and Pico-cell design
  - Allocation of channels
  - Hard and soft handoffs
12. G. Stuber's book is the most appropriate textbook for such course.

**CME 659: Advanced Wireless Networks**

1. Change the title of this course to “Wireless Networks”
  2. The following prerequisite courses should be considered: CME 656- Mobile Communication Systems, CME 638- Antennas, Propagation and Diversity, CME 652- Advanced Digital Communications. In addition, an introductory course to computer networks and algorithms are also needed.
  3. Course topics/description need to be more descriptive rather than listing down all the topics.
  4. Course topics need to be carefully specified and should be broken down into several subsections and add the number of hours corresponding to each topic.
  5. The topics may need to be cut down to fit a 3 hour credit module.
  6. The course topics should include the number of hours needed to deliver the objectives of the course (equivalency with ECTS).
  7. The course topics need to be continuously updated. Newer reference books may need to be recommended.
  8. Course objectives need to be more specific & details describing the technical skills and knowledge to be learnt.
  9. For understanding the wireless networks standards (IEEE 802.11, IEEE 802.16, UWB MB-OFDM, etc), MAC protocols, OFDM techniques, etc, should be covered in this course.
  10. Since MIMO is sufficiently studied in CME 656-Mobile Communication Systems, Directional Antennas are covered in CME 638-Antennas, Propagations and Diversity, these topics should be removed from this course.
  11. Simulation software is needed to implement different wireless protocol in order for students to better understand the concept of the different wireless protocols. Hence, a wireless network simulation lab is highly recommended to be included as a part of this course.
  12. Students are expected to use too Matlab and NS2, it may be better focusing on one of them.
  13. Exams should be given more weight.
- 



## Chapter 6

# Conclusions and Remarks

This report represents the first attempt to assess the existing Master program in wireless communications at the Telecommunications Engineering Department/Yarmouk University since its establishment in 2004. It is the fruit of six months of hard work by the Curriculum Review workgroup who conducted the review through questionnaires and meetings with experts as well as representative of the main stakeholders of the program.

This report has highlighted the main problems associated with the program, its curriculum and its courses. The set of recommendations developed in this report will be used in the curriculum development phase of the Tempus project at the Department. We believe that the data provided in this report will be an invaluable resource for the activities related to reform of the program and development of new curricula.

Although the work has been completed, the workgroup was encountered by a number of obstacles and issues that need to be considered in future activities of the project. These issues can be summarized by the following:

1. Communication with industry

The workgroup was faced by the slow response and enthusiasm of representatives of local telecommunication industry and other organizations in attending meetings and completing the questionnaires. Through discussions with those who attended the workgroup meetings, it was realized that there is some kind of mistrust between academia and industry. People from industry think that the academic sector in Jordan is not putting enough effort to address the needs of industry while academics think that industry is not providing enough feedback to address the needs of industry. This is a historical problem in Jordan on the national level and there is much to be done by all parties in order to bridge the gap between the two parties.

The workgroup managed to overcome this obstacle by relying on personal relationships with people in industry. Mainly, the workgroup members used their contacts specially those who graduated from the Department to reach out to industry. Furthermore, the workgroup did not wait for people to attend meetings at the Department but rather held meetings and presentations with them at their sites where the objectives and the activities of the project were clarified and discussed with them. In each visit of the workgroup members to companies and the subsequent contacts with people either by email or by telephone, the workgroup was successful in getting people complete the review questionnaires.

2. Availability of staff members for attending workgroup meeting

Given the teaching load of the workgroup members, it was a hard for the workgroup to convene on a regular basis. Instead, it was decided in the first few meetings that meeting to be held whenever members complete their tasks. The workgroup leader played a vital role in distributing tasks among workgroup members and in arranging meetings.

3. Communication with EU staff members

One of the planned activities within the curriculum review work package is to hold meetings with EU staff to discuss the review process. However, and given the availability of EU staff, it was hard to arrange such meetings and it was decided that a meeting is needed at the stage of writing the

report of the work package. The workgroup relied on contacts by email and sometimes using Skype to discuss the various issues of the work package.

The workgroup leader called for a meeting with EU staff involved in the work package at DCU in Dublin, Ireland on April 19th, 2011 at the time when two of the workgroup members (Dr. Harb and Dr. Gharaibeh) were on a visit to DCU under deliverable no. 2 (Awareness of EU Educational System). The meeting was a success where various aspects of the review process were discussed and a set of recommendations were given to the workgroup leader to improve this report.



## Appendix A

### Summary of Comments on Program Review

#### *A1. Questionnaire A: Local Academic Staff*

NO	QUESTION	YES	COMMENTS
1.	Are the admission requirements for the program appropriate?	15/17	<ol style="list-style-type: none"> <li>1. Admission requirements.</li> <li>2. Consensus – appropriate.</li> <li>3. TOEFEL should be an admission requirement.</li> <li>4. Prerequisite courses for non communication major</li> </ol>
2.	Are the provided course descriptions informative and complete? Course description need to be revised	7/17	<ol style="list-style-type: none"> <li>1. topics need to be coherent</li> <li>2. include new topics / OFDM / LTE applications etc</li> <li>3. course titles need to reflect contents and objectives of program</li> <li>4. emphasize wireless and relation to wireless in every course</li> <li>5. overlap of topics many different course description</li> <li>6. Simulation of comm. systems not included</li> <li>7. Preferred prerequisites not included (required background for each course)</li> <li>8. Include a statement in each comm. accommodate new technologies and future</li> <li>9. Change CME 614 to Numerical Analysis in Electromagnetics</li> <li>10. Change CME 638 to Antenna, Propagation and Diversity</li> <li>11. Change CME 636 description planner to planner</li> <li>12. Course description in syllabi should match curriculum.</li> <li>13. Course CME 638 should be on Antenna only.</li> <li>14. Change real time DSP to advanced DSP.</li> <li>15. Revise course description of CME 612.</li> </ol>
3.	Do the current offered courses give solid knowledge in wireless communications?	8/17	<ol style="list-style-type: none"> <li>1. Existing course are directed toward research given the proper objectives and outcomes. If a new program to be introduced with the objective of meeting the needs of local industry then more course on wireless technology (and not science) need to be introduced.</li> <li>2. Lack of course on simulation of communication systems and networks.</li> <li>3. Wireless networks should be included as a core.</li> <li>4. Remove diversity from title of CME 638.</li> <li>5. No need for 2 courses on EM.</li> <li>6. Overlap between CME 616 &amp; CME 652.</li> <li>7. Lack of specific program outcomes.</li> <li>8. Need to consult similar programs and industry.</li> <li>9. Remove CME 614 (no need) from core courses.</li> <li>10. Move CME 638 to elective</li> <li>11. Continuous update of the list of courses (yearly).</li> <li>12. Need radio frequency and circuit design course</li> </ol>

4.	Does the current curriculum provide the graduates with enough knowledge and skills for future competitive and changing markets?	7/17	<ol style="list-style-type: none"> <li>1. Curriculum program do not give skills required for market needs.</li> <li>2. Focus only on theory not applications.</li> <li>3. Lack of courses on management.</li> <li>4. Courses are not up to date to cover new technologies.</li> <li>5. Course on RF engineering would be good to meet market needs.</li> <li>6. Collaborate with industry is important.</li> </ol>
5.	Does the reviewer see any redundancy in the program courses?	7/17	<ol style="list-style-type: none"> <li>1. courses on embedded systems redundant (1 course is enough)</li> <li>2. Optical networks (irrelevant to wireless).</li> <li>3. No redundancy in core courses</li> </ol>
6.	Does the program provide the students with strong analytical background for continued formal education at the doctoral level?	14/17	<ol style="list-style-type: none"> <li>1. More focus on research compact of courses (more weight in score).</li> <li>2. Additional courses in mathematics.</li> </ol>
7.	Is the current master program based on industry defined needs?	4/17	<ol style="list-style-type: none"> <li>1. For local industry: program is not based on industry needs</li> <li>2. Simulation skills and technology not included- relevant to industry.</li> <li>3. No engineering management / regulation topics are covered.</li> <li>4. Help students to be problem solvers.</li> <li>5. Does not address installation and application layer area RF planning</li> </ol>
8.	Do the current master courses contribute effectively to an overall master program in wireless communications?	10/17	<ol style="list-style-type: none"> <li>1. Good for MSc. In Telecom but not wireless.</li> </ol>
9.	Does the reviewer recommend any new courses to be included in the core curriculum?	14/17	<p>Courses needed on</p> <ul style="list-style-type: none"> <li>• math applied – optimization</li> <li>• technologies</li> <li>• individual studies</li> <li>• coding to be core</li> <li>• a general course on wireless communication (not necessarily mobile)</li> <li>• Network security, network planning and design.</li> <li>• Wireless network to be core courses</li> <li>• Course on RF engineering.</li> <li>• RF integrated circuit design course.</li> </ul>
10.	Does the reviewer recommend any courses to be removed from the core curriculum?	12/17	<ol style="list-style-type: none"> <li>1. CME 614 removed or moved to electives</li> <li>2. CME 638 changed to Antenna theory and design or moved to electives.</li> </ol>
11.	Do the course syllabi need any improvement?	11/17	<ol style="list-style-type: none"> <li>1. Need to specify objectives and outcomes in each course syllabus.</li> <li>2. Check language.</li> <li>3. Specify assessment tools.</li> </ol>
12.	Does the curriculum use appropriate and sufficient instructional methods?	9/17	<ol style="list-style-type: none"> <li>1. Use of animations, java applications and simulations as instructional methods</li> <li>2. Lab work is needed.</li> <li>3. Online courses are needed.</li> </ol>
13.	Does the reviewer recommend any additional teaching-aid methods or tools?	10/17	<ol style="list-style-type: none"> <li>1. Use seminars.</li> <li>2. Interactive teaching.</li> </ol>

			<ol style="list-style-type: none"> <li>3. Use of simulation.</li> <li>4. Projects/ term papers research.</li> <li>5. Get exposed to teaching methods of international schools.</li> </ol>
14.	Does the reviewer recommend any laboratory-based courses?	12/17	<p>Suggested labs:</p> <ul style="list-style-type: none"> <li>• wireless comm. Lab</li> <li>• wireless network lab</li> <li>• DSP lab</li> <li>• General lab for MSc. Thesis.</li> <li>• Simulation lab.</li> </ul>
15.	Does the current courses evaluation method measure the intended course objectives?	9/17	<ol style="list-style-type: none"> <li>1. More weight on course project.</li> <li>2. No need to fix final grade to 40%.</li> </ol>
16.	Is the current master degree program flexible enough to provide students with the possibility of enrolling in a joint or multiple degree programs?	10/17	
17.	Is the current number of students in the master program comparable to the number of students in a similar master program offered at your institute?	N/A	No information.

**A2. Questionnaire B: Local Industry**

NO.	QUESTION	YES	COMMENTS
1.	Is the current master degree program based totally on theoretical teaching?	5/15	<ol style="list-style-type: none"> <li>1. Labs and practical projects.</li> <li>2. More focus on technology and practical issues. <ul style="list-style-type: none"> <li>• Optical access network.</li> <li>• IP –TV</li> <li>• MPLS</li> <li>• VOIP</li> </ul> </li> <li>3. Could be included on Telecom technology track</li> <li>4. Need to regularly consult industry and university with similar programs to determine needs and update courses, curriculum, and projects accordingly</li> <li>5. Professional development of academic staff and students through industry conferences.</li> <li>6. Include competition and regulation issues in " telecom management track" also policy and management of telecom</li> <li>7. Courses on how to deal with organization and how to develop and market your creativity</li> <li>8. No linkage with industry</li> </ol>
2.	Are the program courses relevant to your organization?	11/15	<ol style="list-style-type: none"> <li>1. Not relevant to core network. <ul style="list-style-type: none"> <li>• Signaling Protocols.</li> <li>• Service flow and logic.</li> <li>• Network service management.</li> </ul> </li> <li>2. Need to consider structure of the network in different courses. <ul style="list-style-type: none"> <li>• Core / switching.</li> <li>• Transmission.</li> <li>• RF.</li> </ul> </li> <li>3. Must keep up with changing technology.</li> <li>4. In Jordan, we are only operator.</li> </ol>
3.	Based on your review of the current master degree program, with regard to the current tools, facilities, and laboratories used, are they relevant to your organization?	4/15	<ol style="list-style-type: none"> <li>1. Need labs on : <ul style="list-style-type: none"> <li>• cellular network</li> <li>• IP network.</li> <li>• Testing labs RF</li> </ul> </li> <li>2. Comprehensive wireless network lab <ul style="list-style-type: none"> <li>• Full mini network.</li> </ul> </li> </ol>

4.	Does the current master program provide graduates with skills necessary for industrial research programs?	3/15	<ol style="list-style-type: none"> <li>1. Industry research is not available in Jordan. <ul style="list-style-type: none"> <li>• Practical issues not covered.</li> <li>• Applied research is not covered/ limited research skills of graduates.</li> <li>• Role of course topics in wireless network.</li> <li>• Radio planning and optimization.</li> <li>• mobile data network <ul style="list-style-type: none"> <li>○ GPRS, EDGE</li> <li>○ HSPA, LTE</li> </ul> </li> <li>• mobile core network <ul style="list-style-type: none"> <li>○ Switching</li> <li>○ Signaling Protocols</li> </ul> </li> </ul> </li> <li>2. Theory will not add new the real life applications</li> </ol>
5.	Does the master program follow the rapid development in communication industry?	2/15	<ol style="list-style-type: none"> <li>1. Elective course should be designed to follow rapid development.</li> <li>2. Annual update of course topics (continuous).</li> <li>3. Cover next generation networks.</li> <li>4. Future IP applications.</li> <li>5. Cover topics related to home- life style applications. <ul style="list-style-type: none"> <li>• Personal area networks.</li> <li>• BAN</li> <li>• Wireless home automation.</li> </ul> </li> <li>6. Need a course that covers evolution of wireless communication. From all aspects <ul style="list-style-type: none"> <li>• Radio</li> <li>• Core</li> <li>• Transmission.</li> <li>• Standards and organization</li> <li>• Stakeholder activities.</li> <li>• Topology of mobile network and function of network elements and their interaction</li> </ul> </li> </ol>
6.	Do the existing curriculum technical contents enhance the employability of graduates at your organization?	5/15	<ol style="list-style-type: none"> <li>1. Program does not address modern telecom industry. Graduates usually do not pass employability exams (interviews).</li> <li>2. Program does not address practical issues (services) related to industry.</li> <li>3. Program useful for working in Radio planning / Transmission but not for core Network and other divisions.</li> <li>4. Curriculum should be developed according to emerging application and services.</li> <li>5. Graduates are over qualified.</li> </ol>
7.	In your view, what is the best approach for measuring the relevance of the program to the needs of local industry?		<ol style="list-style-type: none"> <li>1. get feedback through: <ul style="list-style-type: none"> <li>• teach students</li> <li>• send students to field training at local industry</li> <li>• get feedback performance of students</li> </ul> </li> </ol>

			<ul style="list-style-type: none"> <li>• Update courses, curriculum accordingly.</li> </ul> <ol style="list-style-type: none"> <li>2. Have student projects drawn from industry issues / problems and evaluate curriculum.</li> <li>3. Need a QA mechanism.</li> <li>4. Present new programs to companies and get feedback.</li> <li>5. Perform a demand analysis ( market research questionnaires)</li> <li>6. Run a pilot program and collect feedback from first batch of graduates.</li> <li>7. Open discussion with Telecom industry (workshops)</li> <li>8. Meeting with industry for possible mutual research</li> <li>9. Have instructors spend workdays with industry (management level) and measure relevance of program to industry needs.</li> <li>10. Get sponsorship of program by industry.</li> </ol>
8.	In your opinion, can the current program adequately prepare its graduates to be productive in your organization without further additional training?	4/15	<ol style="list-style-type: none"> <li>1. Graduates need training supplier (vendor) specific courses for operation and management of equipment</li> <li>2. Management courses needed to reduce training of graduates <ul style="list-style-type: none"> <li>• IT training</li> <li>• OSS</li> <li>• Administrative: team work, finance, and project management.</li> </ul> </li> <li>3. Need regulation experience</li> <li>4. Graduates need a lot of training if they are to work in core network but less training if they work in RF transmission</li> <li>5. We definitely need training to operate system ( we don't develop system)</li> </ol>
9.	Compared with job seekers, who do not possess a master degree, can the current program improve their employability rate at your company?	4/15	<ol style="list-style-type: none"> <li>1. No need for master degree. We are not engineering design industry; we just follow and operate new technologies.</li> <li>2. Strong theory for PhD studies</li> <li>3. Not suitable for work</li> <li>4. Could help for senior engineers positions</li> <li>5. It might be for some divisions, but not for core network</li> </ol>
10.	Does the current program prepare its graduates to take leading positions in local and regional communication industry?	1/15	<ol style="list-style-type: none"> <li>1. They need experience to take leading positions.</li> <li>2. Industrial needs not embedded in this program</li> <li>3. Because lack of management and soft skills, finance and economics</li> </ol>
11.	In your view, are there any additional important technical issues that you recommend to include, which are of great interest to your organization?		<ol style="list-style-type: none"> <li>1. add field training to the program</li> <li>2. requirements for admission: <ul style="list-style-type: none"> <li>• strict English requirements</li> <li>• entrants should have GPA above 80%</li> </ul> </li> <li>3. regulation issues should be included</li> <li>4. practical issues (implementation issues) should be included</li> <li>5. include topics like (keywords) <ul style="list-style-type: none"> <li>• fiber terminal equipment</li> <li>• power budget</li> <li>• repeaters</li> <li>• dispersion</li> </ul> </li> </ol>

		<ul style="list-style-type: none"> <li>• boosters</li> <li>• splicing</li> <li>• TDM</li> <li>• IP Hybrid system</li> <li>• NG – SDH</li> <li>• Transmission</li> <li>• Spectrum diversity</li> <li>• Antennas</li> <li>• Protection schemes</li> <li>• Remote network management</li> <li>• DCN, SNMP</li> <li>• Security</li> <li>• Product configuration</li> </ul> <ol style="list-style-type: none"> <li>6. Courses on new mobile application and handsets industries, Mobile technologies (3G, 4G, LTE, HSPA)</li> <li>7. Training of MSc. Students is needed in industry.</li> <li>8. Joint lab for 2G, 3G, and WiMax with industry.</li> <li>9. Introduce technical training courses</li> <li>10. IP based communication should be added</li> <li>11. Labs for new technology in cooperation with local industry</li> <li>12. Add courses like <ul style="list-style-type: none"> <li>• RF , microwave courses</li> <li>• WDM optical networks</li> <li>• IP transmission systems</li> </ul> </li> <li>13. Need two labs <ul style="list-style-type: none"> <li>• Wireless communications</li> <li>• VOIP</li> </ul> </li> </ol>
12.	In your view, what are the most important skills that graduating M.Sc. students should possess to perform their job successfully at your organization?	<ol style="list-style-type: none"> <li>1. Soft skills: communication and negotiation</li> <li>2. Practical experience/ knowledge in future industries</li> <li>3. Language skills – English</li> <li>4. Management and project management team management</li> <li>5. Regulation and policies</li> <li>6. Financial and Admin management</li> <li>7. IT and computer skills</li> <li>8. Lifelong learning component/ skills.</li> <li>9. Some courses related to soft skills (marketing, strategic thinking).</li> <li>10. Good experience with different vendors</li> <li>11. Telecom market knowledge and background</li> </ol>

### A3. Questionnaire C: EU Academic Staff

NO.	QUESTION	YES	COMMENTS
1.	Are the admission requirements for the program appropriate?	9/13	<ol style="list-style-type: none"> <li>1. Specify the level of entrants (GPA, Percentage) or equivalent. What is " good" average consider GPA of engineering courses</li> <li>2. Specify prerequisites for non- comm. major (program skills) Specify program objectives, outcomes.</li> </ol>
2.	Are the provided course descriptions informative and complete?	4/12	<ol style="list-style-type: none"> <li>1. Equivalence of credit hours with ECTS.</li> <li>2. Split credits into practical and theory.</li> <li>3. Syllabi don't match with course description               <ol style="list-style-type: none"> <li>3.1. synchronization not in CME 652</li> <li>3.2. Block interleaving not in CME 616.</li> </ol> </li> <li>4. Include more details on course description               <ol style="list-style-type: none"> <li>4.1. lecture hours</li> <li>4.2. lab work</li> <li>4.3. assessment time</li> <li>4.4. independent learning</li> <li>4.5. course topics</li> <li>4.6. instructional methods</li> <li>4.7. teaching methods</li> </ol> </li> <li>5. follow some template</li> <li>6. details about MSc. thesis need to be specified               <ol style="list-style-type: none"> <li>6.1. Requirement for thesis.</li> <li>6.2. Directions for research.</li> <li>6.3. Process of submission proposal.</li> <li>6.4. Publication requirements.</li> </ol> </li> <li>7. External examiner is a must.</li> </ol>
3.	Do the current offered courses give solid knowledge in wireless communications?	6/12	<ol style="list-style-type: none"> <li>1. Advanced topics and latest technology topics. Technology and standards (GSM, LTE) are all missing.</li> <li>2. Topics like               <ul style="list-style-type: none"> <li>• Multimedia comm.</li> <li>• Network security</li> </ul>               Are not included in any course.             </li> <li>3. User defined issues not covered. Practical issues</li> <li>4. Avoid " introduction" and " fundamentals" in course description</li> <li>5. Avoid " advanced" if used then it should be.</li> <li>6. Many courses seem to be introductory level.</li> <li>7. Advice to students how to choose elective courses.</li> </ol>
<b>No.</b>	<b>Question</b>	<b>Yes</b>	<b>Comments</b>

4.	Does the current curriculum provide the graduates with enough knowledge and skills for future competitive and changing markets?	11/12	<ol style="list-style-type: none"> <li>1. Topics need to be added MANET</li> <li>2. Specify the required skills for market needs, market manufacturers – R&amp;D</li> <li>3. Lack of practical element Real world applications <ul style="list-style-type: none"> <li>• femtocell</li> <li>• WiMax</li> <li>• IP</li> <li>• 802.11</li> <li>• LTE</li> <li>• 4G</li> </ul> </li> <li>4. Add a statement "and energy technologies"</li> <li>5. Need an assessment tool to measure practical skills</li> <li>6. Need to update references to include up to date technologies</li> <li>7. Questions about Labs: Do they need to be included?</li> <li>8. We need a 3 credit hour measurements</li> <li>9. Increase level of courses (not introductory)</li> </ol>
5.	Does the reviewer see any redundancy in the program courses?	7/13	<ol style="list-style-type: none"> <li>1. Redundant material <ul style="list-style-type: none"> <li>• CME 658 CME 656 CDMA</li> <li>• CME 658 CME 652 OFDMA</li> <li>• CME 616 CME 652 Block Codes source codes</li> <li>• CME 659 CME 656 mobile standards + OFDM</li> </ul> </li> <li>2. Courses like quality control and optical networks are irrelevant to the program.</li> </ol>
6.	Do the current master courses contribute effectively to an overall master program in wireless?	12/13	<ol style="list-style-type: none"> <li>1. MANET in wireless network</li> <li>2. Optical network and QC do not contribute.</li> <li>3. Courses on applications and user defined.</li> <li>4. Some courses lack depth.</li> <li>5. Distinction between BSc. and MSc. courses</li> <li>6. Overall objectives of program not specified.</li> <li>7. Clarify cohesiveness in the core course, integration of courses, how courses support each other.</li> </ol>
No.	Question	Yes	Comments

7.	Does the reviewer recommend any new courses to be included in the core curriculum?	11/13	<ol style="list-style-type: none"> <li>1. Split CME 656 into two courses : <ul style="list-style-type: none"> <li>• theory</li> <li>• applications ; technologies and standards</li> </ul> </li> <li>2. course on <ul style="list-style-type: none"> <li>• network security and authentication</li> <li>• Multimedia comm.</li> </ul> </li> <li>3. Programming courses.</li> </ol>
8.	Does the reviewer recommend any new courses to be removed from the core curriculum?	2/13	<ol style="list-style-type: none"> <li>1. Courses on embedded systems</li> <li>2. Change real time signal processing to DSP</li> </ol>
9.	Do the course syllabi need improvements?	10/13	<ol style="list-style-type: none"> <li>1. More details are needed</li> <li>2. Measures of learning outcomes</li> <li>3. Instructional methods</li> <li>4. Specify type of exams</li> <li>5. Specify computer usage</li> <li>6. Specify chapters from which text book.</li> <li>7. More details on project, its outcomes and assessment.</li> </ol>
10.	Does the curriculum use appropriate and sufficient instructional methods?	9/13	Lab practice should be included
11.	Does the reviewer recommend any laboratory-based courses?	9/13	<ol style="list-style-type: none"> <li>1. Split credits into theory and labs for some courses <ul style="list-style-type: none"> <li>• CME 638</li> <li>• CME 652</li> <li>• CME 636</li> </ul> </li> <li>2. Projects enough to provide practical ( no need for specific lab)</li> <li>3. Practice (field trips) at companies should be included in courses.</li> <li>4. There is no need for a lab component in the program. Either as a separate course or through courses (projects).</li> </ol>
12.	Is the current master program recognized for admission in PhD program by higher education institutions in EU? 5. Yes 7/12	7/12	<ol style="list-style-type: none"> <li>6. Need to develop equivalence with ECTS for program to be recognized.</li> <li>7. Need to include a practical component.</li> <li>8. Specs of MSc. thesis and how it is assessed.</li> <li>9. Type of research involved</li> <li>10. Courses need to be " modularized " according to ECTS.</li> </ol>
13.	Is the current master degree program flexible enough to provide students with the possibility of enrolling in a joint or multiple degree programs?	10/13	
14.	Is the current number of students in the master program comparable to the number of students in a typical EU master program?	10/13	40 students is reasonable
15.	Are the current teaching material/methods used in the master program in line with the teaching material/methods used in EU similar programs?	11/13	

16.	Are the current program/course assessment methods used in our college in line with EU standards?	4/13	<ol style="list-style-type: none"> <li>1. Mapping between credit system and ECTS assessment tools.</li> <li>2. Need to develop standards also consider accreditation institutions for assessment that are in line with EU standards based on: <ul style="list-style-type: none"> <li>• competences</li> <li>• work load</li> <li>• level</li> <li>• learning outcomes</li> <li>• profile</li> </ul> </li> <li>3. Develop objective assessment forms/ tools quantitative assessment.</li> <li>4. Consider developing a program that could be recognized by IET or other EU international institution professional engineers (do a research on PE in EU IET).</li> <li>5. Align assessment with outcomes.</li> </ol>
17.	Are the courses relevant to the needs of industry in EU?	10/13	<ol style="list-style-type: none"> <li>1. Consider needs of local industry.</li> <li>2. Specify outcomes of program.</li> <li>3. Need to update teaching material</li> <li>4. Introduce labs relevant to industry needs.</li> <li>5. Tools (software, programming, computer skills) should follow industry needs.</li> <li>6. Raise level of courses (should not be introductory courses)</li> <li>7. More focus on practical labs.</li> </ol>
18.	Does the current program include methods that enable a quality assurance of the graduates?	6/13	Need to measure quality through feedback from current students and post graduates and industry and government (stakeholders) (external evaluation).
19.	Is the current master program requirements comparable with those used in EU universities?	6/13	<ol style="list-style-type: none"> <li>1. Define " good' average</li> <li>2. Provide equivalency with ECTS ( credit vs. ECTS)</li> <li>3. Credit should be given to those who come from industry with practical experience.</li> </ol>
20.	Is the current master program compliant with the European three cycle system using the (ECTS)?	2/13	<ol style="list-style-type: none"> <li>1. Need to develop equivalency with ECTS (ECTS for students), Break credits into <ul style="list-style-type: none"> <li>• contact hours ( in class hours)</li> <li>• study time</li> <li>• search time</li> <li>• exam hours</li> <li>• project hours</li> <li>• lab hours</li> </ul> </li> <li>2. Equivalency is based on information about learning outcomes.</li> <li>3. ECTS load for instructor <ul style="list-style-type: none"> <li>• teaching hours</li> <li>• time of individual or group work</li> <li>• Could include preparation of lecture notes, seminar, lab work, and required revisions.</li> <li>• Writing of papers / projects/ presentations</li> <li>• Practical work (labs or practical training)</li> <li>• Time to prepare exams and assessment procedures.</li> </ul> </li> </ol>
<b>No.</b>	<b>Question</b>	<b>Yes</b>	<b>Comments</b>

21.	Is it possible for our students to transfer course credit hours into the current ECTS system?	8/13	Depends on the local EU institution
22.	How do you rate this master program in comparison with similar EU programs?		<ol style="list-style-type: none"><li>1. The program is appropriate for research not for industry</li><li>2. Lack of details on contents and assessment methods</li><li>3. More emphasis on practical issues</li><li>4. Need external examination as one assessment methods</li><li>5. ECTS -like assessment</li><li>6. Design MSc. Thesis and transferable skills need to address aspects and learning outcomes</li><li>7. Develop guidelines about topics chosen as MSc thesis</li></ol>



## Appendix B

### Analysis of Reviews of Individual Courses

#### *B. 1 CME 610: Random Processes*

**Tempus Project No. 511074  
Work Package No.1  
Deliverable No. 1  
Review of the Existing Curriculum**

**Individual Course-Review  
Course Title: Random Processes CME 610  
Prepared by  
Dr. Khaled Gharaibeh  
26/3/2011**

**A. Introduction**

This report constitutes the review of the Random Process course (CME 610) which was done by a number of professors and a number of students. It consists of analysis of the data obtained from a questionnaire which was completed by reviewers who are experts in the field. The analysis presented in this report summarizes the major comments obtained from those questionnaires and provides recommendations to improve the course module. Appendix I consist of the statistic obtained from the questionnaires.

**B. The Questionnaire**

The questionnaire was prepared by the curriculum review workgroup and consists of 15 questions about the following major aspects of the course such as:

- 1) Course contents, description and syllabus
- 2) Teaching methodologies
- 3) Relevancy to the overall program

The course was reviewed by 12 experts in the field. 7 of them were from EU partner universities, 3 were from local partner universities and remaining 2 reviews were by the course instructors at the Telecommunications Engineering Department-Yarmouk University. In addition, the course was reviewed by 15 students who took the course during the First Semester 2010/2011.

**C. External Review:**

The reviewers indicated with a good percentage that the course description, syllabus, text book and references and grading policy are appropriate. It was also noted that the course prerequisites are appropriate.

**C.1: Course contents, Description and Syllabus**

The following were indicated as the major strengths and weaknesses of the course module with regard to contents, course description and syllabus.

**Strengths**

- 1- Good depth and breadth of coverage in mathematical background as well as applied /advanced signals - related topics.
- 2- Random processes well covered; useful for spectral estimation, system identification, etc.
- 1- Inclusive of a variety of concepts.
- 3- The course covers advanced topics on random processes and provides students with tools needed to doing research in related fields.
- 4- The course gives the student the basic tools to understand important topic in digital and mobile communication course. For example the performance analysis of digital modulation over multipath channels. Also the course helps student in their research work in different area of new wireless technology.
- 5- Provide the essential good knowledge in random processes.
- 6- The material covered helps students understand how to simulate communication systems in related software packages such as Matlab.
- 7- Students learn the theory needed for understanding advanced topics in wireless communications
- 8- Good coverage of the basic and important topics of the course.

**Weaknesses**

The following items were indicated as the major Weaknesses of the course:

- 1- Assessment materials provided (written exams) do not appear to cover some topics e.g. "special processes " topics – perhaps those are examined through the project/ homework?

- 2- No learning outcomes, no info on teaching methods.
- 3- The content is mainly theoretical.
- 4- The course does not address the problem of simulation of communication systems. This can be included as a course project with higher weight than the current weight on the project.
- 5- The first three course topics should be covered in an undergraduate course. Queuing theory should be added to the topics as well as some applications on wireless systems.

### ***C2: Teaching Methodologies***

The following comments were raised by the reviewers with regard to teaching methodologies:

- List of references should include more up to date books.
- More focus on simulation should be included. A course project should have a higher weight in the total course grade
- The course should have a more visible practical component.
- The weight of the HW assessment should be increased.

### ***C3: Contribution to Overall Program:***

Some reviewers indicated that such a course is typically delivered as part of the mainstream courses. Others indicated that the fundamentals covered by the course appear very complementary to a number of other courses within the curriculum. Furthermore, it was indicated that since the course does not have a practical element, its contents could be fit into other courses. A good percentage of the reviewers (8/12) indicated that this course can be discontinued and its material to be included in other courses such as CME 618, CME 612, CME 616 and CME 652 while the first few course topics should be covered in an undergraduate course.

### **D. Internal Review-Self Assessment:**

The instructors of the course indicated that this course is very important to the program since it gives the necessary tools for other courses. However, they indicated that some issues hinder the achievement of the course objectives. These can be summarized as:

- The lack of teaching resources (such as equipped classrooms, computer labs) makes the teaching process partially efficient.
- The weak background of the student in simulation which makes course projects is not very effective.
- The weak background in advanced math make it difficult to cover more advanced topics and applications and hence, it make it hard to completely achieve the objectives of the course.

They recommended the following:

- This course must be made a prerequisite for other courses such as digital communications and mobile communications
- The course syllabus needs to specify clearly the course outcomes and objectives and their relationship to the overall program outcomes. Also, adding more references and web links which help students find learning resource
- More focus on simulation should be included.
- A course project should have a higher weight in the total course grade
- More examples and applications related to wireless Communications need to be explained.
- Student should take prior to this course advance course in math. More project work based on Matlab code should be considered.

### **E: Student Review**

Most students were happy with the course in general and its contents in particular. They indicated that the material is very useful for them since it constitutes the basic knowledge which they need to understand other advanced courses such as CME 652, CME656 and CME 658.

The main concern by students is the fact that the course needs a good knowledge and background in Math and Signals and Systems.

Most of the students indicated that Homework and projects are very efficient. Some recommended increasing the weight on the course project. However, they indicated that the course contents must include some practice on Matlab to enable the project to be efficiently conducted.

Some students indicated that the material is relatively abstract and they recommended to include examples on wireless communications and to illustrate how random processes are useful to solve problems related to real world communication systems.

### **F: Recommendations**

The following remarks/recommendations were indicated to improve the course module:

- 1) Most reviewers recommended inclusion of the course contents in other courses in the curriculum.
- 2) If the course is to be continued then the following issues need to be addressed:
  - a. Course title:
    - Changing the course title to Random Processes in Communication Systems
  - b. Syllabus
    - Include learning objectives and outcomes is a must in the course syllabus
    - Update the reference list in the syllabus to include up-to-date references
    - More details in the course syllabus are required about the assessments used.
    - The inclusion of a project and homework assignments, in addition to written examinations, to give a good balance.
  - c. Course topics:

Include more practical topics such as

    - simulation of random processes
    - system identification using random processes
    - Estimation theory.
    - Kalman predictor and filter, wiener filters.
    - Include Applied topics, e.g. random walks, Poisson, system identifications etc. in the written examinations.
    - More specific relations to practical exercises.
  - d. Teaching Methods
    - The course should have a more visible practical component. This could be done by increasing the weight on course project.
    - Increased use of the internet resources.
    - Using computer simulations to illustrate the concepts taught in the course

## G. Statistics

Table B1: Expert Review

No.	Question	Yes	No	N/A
1	Is the title of the course appropriate and informative?	8	4	0
2	Does the course syllabus include the minimum information?	11	1	0
3	Are course syllabus changes needed?	4	8	
4	Does this course provide an effective orientation module?	9	2	1
5	Are course materials, teaching tools, and text book relevant to the course and appropriate for learning the course objectives?	12	0	0
6	Are there any course(s) in the program with complementary, related or overlapping content with this course?	5	7	
7	Are there important topics or areas of expertise that are not adequately covered?	1	11	
8	Are the requirements (prerequisites, courses) appropriate for a high quality program?	9	0	3
9	Is the grading policy for this course adequate?	11	1	0
10	Are the employed teaching methodologies adequate?	9	2	1
11	Does your institute offer a similar course?	2	5	5
12	Does this course contribute effectively to overall core curriculum?	9	3	0
13	Do you recommend continuance (inclusion) of this course in core curriculum?	4	7	1

Table B2: Student Review

#	Question	Yes	No	N/A
1	Is the title of the course appropriate and informative?	15	0	0
2	Does the course syllabus include the minimum information?	15	0	0
3	Are course syllabus changes needed?	13	1	1
4	Does this course provide an effective orientation module?	15	0	0
5	Are course materials, teaching tools, and text book relevant to the course and appropriate for learning the course objectives?	13	1	1
6	Are there any course(s) in the program with complementary, related or overlapping content with this course?	8	7	0
7	Are there important topics or areas of expertise that are not adequately covered?	3	12	0
8	Are the requirements (prerequisites, courses) appropriate for a high quality program?	13	2	0
9	Is the grading policy for this course adequate?	14	1	0
10	Are the employed teaching methodologies adequate?	14	1	0
11	Does your institute offer a similar course?	0	0	15
12	Does this course contribute effectively to overall core curriculum?	14	1	
13	Do you recommend continuance (inclusion) of this course in core curriculum?	15	0	0

## ***B. 2 CME 612: Real Time Signal Processing***

**Individual Course-review Form  
Course Number: CME 612  
Real Time Signal Processing  
Bassam Harb**

In this report, a detailed analysis of the reviews conducted by EU, local and our professors on the course CME 612 (Real-Time Signal Processing) is presented. It contains a summary of the major strengths and weaknesses of the course and recommendations which should be taken into account in improving the quality of the course in the curriculum development process. The evaluation process has been conducted based on the questionnaires developed for all partners involved in the curriculum review process.

### ***Questionnaires:***

To facilitate the review process, a questionnaire has been prepared by the curriculum review workgroup. This questionnaire includes questions concerning the content of the course, teaching methodology and the relevance of the course to the overall program. These questionnaires were sent to the reviewers along with the review package which includes the syllabus of the course, course description and samples of the exams. The review process was conducted by 6 reviewers (3 from EU and 3 from local universities). Also, five students were involved in the review process.

### ***Analysis:***

- 1- Most of the reviewers agreed on that the title of the course is appropriate, with some of the reviewers suggested the title the phrase "Real – Time" to be removed from the title.
- 2- All the reviewers indicated that the course syllabus include the minimum information. On the other hand, almost 50% of the reviewers stated that the course's scope is of an introductory level and needs to be modified to include advance topics on the field of signal processing.
- 3- A good percentage of the reviewers indicated that the course materials and teaching tools are appropriate for course objectives, but some of them criticized the course by not having a lab for this course in order for the students to gain practical experience.
- 4- Based on reviewers' comments, there were many courses in the curriculum that complement this course such as CME 656, CME 652, CME 640, CME 658, embedded system. All of them agreed on that the course stands on its own and does not duplicate other courses.
- 5- 50% of the reviewers suggested that the topics in the course should be covered in depth, while other sees the course is adequately covered the needs. There was concern by a reviewer that some course objectives are not assessed in the exams.
- 6- The reviewers agreed on that the prerequisites of the class are appropriate, but there was a concern about other students who enters the program from other fields such as computer engineering. Those students need to take classes in discrete time signals and transform.
- 7- With regarding to grading policy of this course, all the reviewers say it is adequate, but it is not well distributed. Some of the reviewers suggested that it needs to be clarify what each assessment covers. Also, more information is required about the format of each type of assessment. One of the reviewer suggested that the course should be mostly practical and should be examined as such-in the form of a project rather than an exam.

8- Regarding teaching methodology, the reviewers indicated that it is adequate. Some of them suggested that more practical sessions are needed, whereas, two of them were not certain.

9- This class is similar to modules which offer by all our EU partners.

10- All of the reviewers agreed on that this course contribute effectively to the overall core curriculum since it is very popular with students who are of the more traditional engineering bent.

**Strengths:**

1. Practical applications are possible after completion.
2. The course includes a comprehensive list of topics.
3. Good coverage of the basic and important topics of the course.

**Weaknesses:**

1. No practical lab design component.
2. Not all objectives are examined.

**Recommendations:**

1. When describing the course topics, it is not clear at which book and chapter is referring to.
2. Would need much more information to decide if changes needed.
3. The course material is sufficient, but adding some MATLAB assignments would further improve the course.
4. Statistical signal processing should be included as graduate course.
5. Statistical signal processing or spectral analysis is more relevant to wireless communication program and consequently the entire course description should be changed accordingly.

**Statistics**

**Course Title: "CME 612 Real Time Signal Processing"**

**Table I: Expert Review**

#	Question	Yes	No	N/A
1	Is the title of the course appropriate and informative?	5	1	0
2	Does the course syllabus include the minimum information?	5	1	0
3	Are course syllabus changes needed?	2	4	1
4	Does this course provide an effective orientation module?	3	0	3
5	Are course materials, teaching tools, and text book relevant to the course and appropriate for learning the course objectives?	5	1	0
6	Are there any course(s) in the program with complementary, related or overlapping content with this course?	3	3	0
7	Are there important topics or areas of expertise that are not adequately covered?	2	4	0
8	Are the requirements (prerequisites, courses) appropriate for a high quality program?	3	1	2
9	Is the grading policy for this course adequate?	5	0	1
10	Are the employed teaching methodologies adequate?	5	0	1
11	Does this course contribute effectively to overall core curriculum?	6	0	0
12	Do you recommend continuance (inclusion) of this course in core curriculum?	4	2	0
13	Does your institute offer a similar course?	3	0	3

### B. 3 CME 614: Numerical Techniques in Electromagnetics

**Individual Course-review Form**  
**Course Number: CME 614**  
**Numerical Analysis in Electromagnetic**  
**Asem Zoubi**

#### 1. Introduction

In this report, a summary of the review of the Numerical analysis in Electromagnetic (CME 614) done by some professors from EU universities and local universities. This report consists of the analysis of the data obtained from the questionnaire which was completed by expert reviewers in this field. The analysis presented in this report summarizes the major comments obtained from those questionnaires and provides recommendations to improve course module. Appendix I consists of the statistics obtained from the questionnaires.

The questionnaire was prepared by the curriculum review workgroup and consists of 15 Questions about the following major aspects of the course such as:

1. Course contents, description and syllabus.
2. Teaching methodologies
3. Relevance to the overall program

The course was reviewed by 10 experts in the field of Electromagnetics and antennas. 6 of them were from EU partner universities, 3 were from local partner universities, and the last review was by the course instructor at the Telecommunication Department at Yarmouk University.

#### 2. External Review

The reviewers indicated that the syllabus is informative, course materials, teaching tools, and text book are appropriate. Also, they indicated that this course contributes effectively to the core curriculum, and they recommend inclusion of this course in the core curriculum. Also, they mentioned that the course title should be "Numerical analysis in *Electromagnetics*", and course description has many typographical errors.

##### ***Course contents, description, and syllabus:***

The reviewers indicated the major strengths and weaknesses of the course module with regard to course title, course description, contents, and syllabus. The strengths, weaknesses, and recommendations are listed below.

##### ***Strengths:***

1. The course syllabus is informative; however it should describe the project and assignments in more details.
2. The text book is an excellent choice.
3. The use of commercial software is very important for students and for the methodology.
4. The course covers numerical methods which are very important for electromagnetics.
5. This course is a complement course to antennas and propagation.
6. Course covers an area of growing importance.
7. Course instructor has impressive pedigree in this area.
8. Contents are very well selected, and this course provides a comprehensive summary of topics.
9. The grading policy is suitable for this course.

##### ***Weaknesses:***

1. Assessment material does not place material strongly enough in the context of EM applications.
2. There should be more detailed treatment of complex problems (i.e., fully 3D problems with staggered E and H Yee grids).
3. Exam format limits the assessment to relatively simple problems.
4. There should be more emphasis on project and assignment work.

***Recommendations:***

1. The course title should be "Numerical analysis in *Electromagnetics*", and the contents should be more related to EM rather than mathematics.
2. There should be pre-requisite courses such as electromagnetics and linear algebra courses.
3. There should be more emphasis on application to EM problems.
4. More emphasis (larger percentage weighting) on project and assignments.
5. Integrate this course more firmly with CME 638 (Antennas, propagation, and diversity).
6. Add more references.
7. Cover a wider range of topics to a deeper level.
8. Use the text book "Computational methods for Electromagnetics" by Peterson, Ray, and Mettra as an alternative source.
9. More treatment of the source of errors in numerical solutions and how they can propagate.

**3. Internal Review – Self Assessment**

The reviewers indicated that this course contributes effectively to the core curriculum, and it gives the students the ability to simulate and solve numerical problems related to Electromagnetics and antennas. The following is the summary of the strengths, weaknesses, and recommendations.

***Strengths and weaknesses:***

1. The grading policy is adequate for this course.
2. The course contributes effectively to the core curriculum.
3. Text book is a good choice for this course.
4. This course is beneficial to those who will continue their Ph.D. in Electromagnetics or antennas.
5. It covers most numerical methods used for solving EM problems.
6. The student learns different commercial software and uses them to simulate and optimize different antenna designs.
7. Improve programming skills for students
8. Exams for this course do not reflect the contents of the course (it is difficult to solve EM problem numerically in one or two hour exams).

***Recommendations***

1. The course syllabus should be changed to include more details about practical problems and projects.
2. Pre-requisite courses should be added in the course description (such as: Electromagnetics II "CME 442", Linear algebra "Math 212", and Engineering computation and simulation "CPE 310").
3. They recommend moving this course to be an elective course.
4. The title of the course should be changed to "Numerical analysis in *Electromagnetics*".
5. Commercial software should be available for students.

*Statistics***Course Title: " CME 614 Numerical Analysis in Electromagnetic"****Table I: Expert Review**

#	Question	Yes	No	N/A
1	Is the title of the course appropriate and informative?	9	1	0
2	Does the course syllabus include the minimum information?	10	0	0
3	Are course syllabus changes needed?	1	7	2
4	Does this course provide an effective orientation module?	5	0	5
5	Are course materials, teaching tools, and text book relevant to the course and appropriate for learning the course objectives?	7	0	3
6	Are there any course(s) in the program with complementary, related or overlapping content with this course?	1	6	3
7	Are there important topics or areas of expertise that are not adequately covered?	1	7	2
8	Are the requirements (prerequisites, courses) appropriate for a high quality program?	4	3	3
9	Is the grading policy for this course adequate?	4	4	2
10	Are the employed teaching methodologies adequate?	6	0	4
11	Does this course contribute effectively to overall core curriculum?	7	3	0
12	Do you recommend continuance (inclusion) of this course in core curriculum?	6	2	2
13	Does your institute offer a similar course?	5	1	0

## ***B. 4 CME 616: Information Theory and Coding***

**Individual Course-review Form  
Course Number: CME 616  
Information Theory and Coding  
Bassam Harb**

### **1. Introduction**

In this report, a detailed analysis of the reviews conducted by EU, local and our professors or the CME 616 (Information Theory and Coding) is presented. It contains a summary of the major strengths and weaknesses of the course and recommendations which should be taken into account in improving the quality of the course in the curriculum development process. The evaluation process has been conducted based on the questionnaires developed for all partners involved in the curriculum review process.

### **2. Questionnaires**

To facilitate the review process, a questionnaire has been prepared by the curriculum review workgroup. This questionnaire includes questions concerning the content of the course, teaching methodology and the relevance of the course to the overall program. These questionnaires were sent to the reviewers along with the review package which includes the syllabus of the course, course description and samples of the exams. The review process was conducted by 10 reviewers ( 7 from EU and 3 from local universities).

### **3. Analysis**

- 1- All of the reviewers agreed on that the title of the course is appropriate.
- 2- All the reviewers indicated that the course syllabus includes the minimum information.
- 3- A good percentage of the reviewers indicated that the course materials and teaching tools are appropriate for course objectives, but some of them criticized the course by not having practical coding concept in order for the students to gain practical experience. Also, Viterbi algorithm, convolutional code decoding and Trellis coded modulation should be included.
- 4- Most of the reviewers think the course provide an effective orientation module. Also, the text book and course materials look relevant.
- 5- Some of the reviewers suggested that the topics in the course should be covered in depth, while other sees the course is adequately covered the needs. There was concern by a reviewer that some topics appears in the catalog data, but is not covered in the course.
- 6- The reviewers agreed that the prerequisites of the class are appropriate, but some of the reviewers suggested that CME 652 could be a prerequisite.
- 7- With regarding to grading policy of this course, all the reviewers say it is adequate, but it is not well distributed. Some of the reviewers suggested that it needs to be clarify what each assessment covers. Also, more information is required about the format of each type of assessment.
- 8- Regarding teaching methodology, the reviewers indicated that it is adequate. Some of them suggested that more practical sessions are needed, whereas, two of them were not certain.
- 9- This class is similar to modules which offer by all our EU partners.
- 10- All of the reviewers agreed on that this course contribute effectively to the overall core curriculum since it is very relevant course in telecom domain. Also, some of the reviewers indicated that this course should be moved to the core list since it represents a basic block of any communication system.

### ***Strengths:***

1. It gives the students a complete idea of channel and source coding.
2. The course includes a comprehensive list of topics and covers coding very well.

3. Self-contained and provide excellent knowledge in coding theory.

**Weaknesses:**

1. No practical lab design component.
2. Lack of real examples describing channel/source coding (GSM, CD- audio,...).
2. More details are required about the assessment used.

**Recommendations:**

1. Inclusion of RS/BCH codes, turbo codes and LPDC coding.
2. More information is needed on teaching method.
3. Tour industry projects that could be used for integrating the course with the current industry demands.
4. Adding more practical sessions and assessments.
5. Practical components should be visible.
6. The course should be moved to the core list.

**4. Statistics**

**Course Title "CME 616 Information Theory and Coding"**

**Table I: Expert Review**

#	Question	Yes	No	N/A
1	Is the title of the course appropriate and informative?	10	0	0
2	Does the course syllabus include the minimum information?	9	1	0
3	Are course syllabus changes needed?	4	5	0
4	Does this course provide an effective orientation module?	8	1	1
5	Are course materials, teaching tools, and text book relevant to the course and appropriate for learning the course objectives?	9	0	0
6	Are there any course(s) in the program with complementary, related or overlapping content with this course?	2	7	1
7	Are there important topics or areas of expertise that are not adequately covered?	3	6	0
8	Are the requirements (prerequisites, courses) appropriate for a high quality program?	7	1	1
9	Is the grading policy for this course adequate?	9	0	0
10	Are the employed teaching methodologies adequate?	7	1	2
11	Does this course contribute effectively to overall core curriculum?	5	1	1
12	Do you recommend continuance (inclusion) of this course in core curriculum?	10	0	0
13	Does your institute offer a similar course?	10	0	0

## ***B. 5 CME 638: Antenna, Propagation and Diversity***

**Individual Course-review Form**  
**Course Number: CME 638**  
**Antennas, propagation and Diversity**  
**Asem Zoubi**

### **1. Introduction**

In this report, a summary of the review of the Antennas, wave, and diversity course (CME 638) done by some professors from EU universities, local universities, and a number of master students. This report consists of the analysis of the data obtained from the questionnaire which was completed by expert reviewers in this field. The analysis presented in this report summarizes the major comments obtained from those questionnaires and provides recommendations to improve course module. Appendix I consists of the statistics obtained from the questionnaires.

### **2. The Questionnaire**

The questionnaire was prepared by the curriculum review workgroup and consists of 15 Questions about the following major aspects of the course such as:

4. Course contents, description and syllabus.
5. Teaching methodologies
6. Relevance to the overall program

The course was reviewed by 10 experts in the field of antennas, waves and propagation. 6 of them were from EU partner universities, 3 were from local partner universities, and the last review was by the course instructor at the Telecommunication Department at Yarmouk University. In addition, the course was reviewed by 8 students who took the course during the first semester in the academic year 2010/2011.

### **3. External Review**

The reviewers indicated that the syllabus is informative, course materials, teaching tools, and text book are appropriate. Also, they indicated that this course contributes effectively to the core curriculum, and they recommend inclusion of this course in the core curriculum.

#### ***Course contents, description, and syllabus:***

The reviewers indicated the major strengths and weaknesses of the course module with regard to course title, course description, contents, and syllabus. The strengths, weaknesses, and recommendations are listed below.

#### ***Strengths:***

10. The text book is an excellent choice.
11. The course gives a very strong treatment of antenna fundamentals with emphasis on design principles.
12. Contents are very well selected.
13. The grading policy is suitable for this course.
14. The students learn how to design and simulate different kinds of antennas using commercial software.
15. The syllabus is informative.
16. This course is a complement course to numerical analysis in Electromagnetics.
17. This course provides a comprehensive summary of topics.

**Weaknesses:**

5. There is no mention to additional teaching techniques.
6. There is a need to focus on specific areas and provide in-depth experience to students.
7. There should be more emphasis on project and assignment work.
8. There should be pre-requisite courses such as electromagnetics.
9. Propagation and diversity topics are not covered in the course.

**Recommendations:**

1. Treatment of propagation issues, as well as fading and diversity.
2. More emphasis (larger percentage weighting) on project and assignments
3. Integrate this course more firmly with CME 614 (Numerical analysis in Electromagnetics).
4. Clearly identify pre-requisites for this course.
5. The contents of this course need to be more specific.
6. Add more references.

**4. Internal Review – Self Assessment**

The reviewers indicated that this course contributes effectively to the core curriculum, and it gives the students the ability to design and simulate different kinds of antennas for many applications. The following is the summary of the strengths, weaknesses, and recommendations.

**Strengths and weaknesses:**

9. The grading policy is adequate for this course.
10. The course contributes effectively to the core curriculum
11. The title of the course should be changed.

**Recommendations**

6. The course syllabus should be changed and include most types of antennas.
7. Numerical and software tools should be included in the course description and syllabus.
8. Pre-requisite courses should be added in the course description (they suggested Electromagnetics and microwave engineering courses).
9. They recommend inclusion of this course in the core curriculum.
10. Adding antenna types that are used in cell phones and ultra wide antennas to the course contents

**5. Student Review**

The students were happy with this course and its contents since it offers the knowledge of antenna fundamentals and types. Also they learned how to design and simulate different kinds of antennas using commercial software.

Some students suggested adding pre-requisites for this course such as Electromagnetics and calculus (vector analysis), since these courses are needed to understand antenna analysis.

Most of the student indicated that grading policy is adequate, and Homework and projects are very efficient. Also, they indicated that the design and simulation of antennas using commercial software helped them to understand course contents.

## 6. Statistics

## Course Title: "CME 638 Antennas, propagation and Diversity"

Table I: Expert Review

#	Question	Yes	No	N/A
1	Is the title of the course appropriate and informative?	5	5	0
2	Does the course syllabus include the minimum information?	10	0	0
3	Are course syllabus changes needed?	7	3	1
4	Does this course provide an effective orientation module?	8	0	2
5	Are course materials, teaching tools, and text book relevant to the course and appropriate for learning the course objectives?	6	3	1
6	Are there any course(s) in the program with complementary, related or overlapping content with this course?	2	8	0
7	Are there important topics or areas of expertise that are not adequately covered?	5	4	1
8	Are the requirements (prerequisites, courses) appropriate for a high quality program?	6	1	3
9	Is the grading policy for this course adequate?	7	3	0
10	Are the employed teaching methodologies adequate?	8	1	1
11	Does this course contribute effectively to overall core curriculum?	10	0	0
12	Do you recommend continuance (inclusion) of this course in core curriculum?	7	3	0
13	Does your institute offer a similar course?	5	1	0

Table II: Student Review

#	Question	Yes	No	N/A
1	Is the title of the course appropriate and informative?	8	0	0
2	Does the course syllabus include the minimum information?	8	0	0
3	Are course syllabus changes needed?	1	7	0
4	Does this course provide an effective orientation module?	8	0	0
5	Are course materials, teaching tools, and text book relevant to the course and appropriate for learning the course objectives?	7	1	0
6	Are there any course(s) in the program with complementary, related or overlapping content with this course?	6	2	0
7	Are there important topics or areas of expertise that are not adequately covered?	1	7	0
8	Are the requirements (prerequisites, courses) appropriate for a high quality program?	7	1	0
9	Is the grading policy for this course adequate?	8	0	0
10	Are the employed teaching methodologies adequate?	8	0	0
11	Does this course contribute effectively to overall core curriculum?	8	0	0
12	Do you recommend continuance (inclusion) of this course in core curriculum?	8	0	0
13	Does your institute offer a similar course?	-	-	-

**B. 6 CME 652: Advanced Digital Communications****Tempus Project No. 51174  
Work Package No. 1  
Deliverable No. 1  
Review of the Existing Curriculum****Individual Course Review  
Course Title: Advance Digital Communication CME 652  
Prepared by  
Dr. Ahmad Alshamali  
May 16, 2011****1. Introduction**

This report presents the review of the Advance Digital Communication (CME 652) which was done by 10 professors and 8 students (the reviewers). It summarizes the data obtained from questionnaire (individual course review form) that was filled by reviewers. It also presents the reviewers comments and their recommendations. Appendix 1 consists of the statistics obtained from the questionnaires.

**2. The Questionnaire**

The review form was prepared by the curriculum review workgroup. It consists of 15 questions about the followings:

- Course contents, description and syllabus
- Teaching Methodologies
- Relevancy to the overall program

As stated before the course was reviewed by 10 professors; 6 from EU partner universities, 3 from local partner universities and a reviewer from YU (instructor). In addition, the course was reviewed by 8 students who studied the course during the first semester 2010/ 2011.

**3. External Review**

More than 90% of the reviewers indicated that the course description, grading policy, teaching methodology, syllabus, text book are adequate. All of them indicated that the course contributes effectively to overall curriculum and they recommended the inclusion of the course in the core curriculum. The following were indicated as the major strength and weaknesses with regard to course contents, course description and syllabus:

***Strengths***

1. The course provides an appropriate MSc level material.
2. It provides solid coverage of digital communication topics.
3. This course can be considered as a prerequisite for the thesis.
4. The text book and references are adequate.
5. The given material is good for other courses such as CME 656.
6. Sample examinations appear to be appropriately challenging.
7. The course contributes effectively to the overall core curriculum.

***Weaknesses***

1. Assessment material is not enough, more information is needed.

2. Advance topics ( OFDM, Synchronization, adaptive equalization and digital signaling over fading channel) are not covered
3. Additional information needs to be added to the course syllabus (Detailed breakdown week by week for the covered material).
4. Lacks of practical aspects in the methodology.
5. No lab sessions.
6. No relevant internet sources.
7. Some overlap with CME 616.
8. The lack use of Matlab and simulation within the course material.

#### **4. Internal review**

Only one reviewer (course instructor) filled the review form. He indicated that the course is very important to the program since it gives the background material for other courses. He indicated that some issues hinder the achievement of the course objectives. These can be summarized as follow:

- The lack of teaching resources ( well equipped class room, computer labs) makes the teaching process partially efficient
- The weak background in advance math made it too hard to cover the advance topics. Also, weak background in random processes because some times both CME 610 and CME 652 are studied by the student in parallel which increased the difficulty to achieve course objectives.
- The weak background in Matlab simulation made course project not very efficient.

He recommended the following:

- The word advance should be removed, that is the course title should be Digital Communication only.
- The students should have strong background in advance math.
- The students should study the random processes course (CME 610) before this course.
- More focus on computer simulation which will enhance the understanding of the course as well as make the project more efficient.

#### **5. Student review**

All the students indicated that the course should be taken after the completion of the prerequisite one (CME 610), as all of them studied both courses in the same semester. They had not any comment regarding the grading policy. All of them indicated that the course contribute effectively to overall core curriculum

#### ***Recommendations***

The following remarks/ recommendation were indicated to improve the course module:

1. All reviewers recommended the inclusion of the course in core curriculum. However some recommended removing the source coding chapter to remove the overlap with the course CME 616 and add new chapter on OFDM. Other recommended the addition of more advance topics such as synchronization and adaptive equalization.
2. Most of the reviewers recommended more focusing on simulation and project work.
3. Some of the reviewer recommended that the word advance in title of the course should be removed.
4. Course instructor and the students strongly recommended that the completion of CME 610 before studying this course.
5. More detailed in course syllabus should be included
6. More emphasis should be considered on practical components

## 6. Statistics

**Table 1 Professors review**

#	Question	Yes	NO	N/A
1	Is the title of the course appropriate and informative?	9	1	0
2	Does the course syllabus include the minimum information?	7	3	0
3	Are the course syllabus changes needed?	5	5	
4	Does the course provide an effective orientation module?	10	0	0
5	Are the course materials, teaching tools and text book relevant to the course and appropriate for learning the course objective?	10	0	0
6	Are there any course(s) in the program with complementary, related or overlapping content with this course ?	6	4	0
7	Are there important topics or areas of expertise that are not adequately covered?	3	7	0
8	Are the requirements (prerequisite, course) appropriate for high quality program?	10	0	0
9	Is the grading policy for this course adequate?	8	2	0
10	Are the employed teaching methodologies adequate?	10	0	0
11	Does your institute offer a similar course?	5	3	2
12	Does this course contribute effectively to overall curriculum?	8	0	2
13	Do you recommend the inclusion of this course in core curriculum?	8	0	2

**Table 2 Student review**

#	Question	Yes	NO	N/A
1	Is the title of the course appropriate and informative?	8	0	0
2	Does the course syllabus include the minimum information?	8	0	0
3	Are the course syllabus changes needed?	3	5	0
4	Does the course provide an effective orientation module?	8	0	0
5	Are the course materials, teaching tools and text book relevant to the course and appropriate for learning the course objective?	8	0	0
6	Are there any course (s) in the program with complementary, related or overlapping content with this course?	5	1	0**
7	Are there important topics or areas of expertise that are not adequately covered?	7	1	0
8	Are the requirements (prerequisite, course) appropriate for high quality program?	7	1	0
9	Is the grading policy for this course adequate?	8	0	0
10	Are the employed teaching methodologies adequate?	7	1	0
12	Does this course contribute effectively to overall curriculum	8	0	0
13	Do you recommend the inclusion of this course in core curriculum?	8	0	0

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<sup>4</sup> 2 students did not answer the question

**B. 7 CME 656: Advanced Mobile Communications****Tempus Project No. 51174  
Work Package No. 1  
Deliverable No. 1  
Review of the Existing Curriculum****Individual Course Review  
Course Title: Mobile Communication Systems CME 656  
Prepared by  
Dr. Ahmad Alshamali  
May 16, 2011****1. Introduction**

This report presents the review of the Mobile Communication systems (CME 656) which was done by 11 professors (the reviewers). It summarizes the data obtained from questionnaire (individual course review form) that was filled by reviewers. It also presents the reviewers comments and their recommendations. Appendix 1 consists of the statistics obtained from the questionnaires.

**2. The Questionnaire**

The review form was prepared by the curriculum review workgroup. It consists of 15 questions about the followings:

- Course contents, description and syllabus
- Teaching Methodologies
- Relevancy to the overall program

As stated before the course was reviewed by 11 professors; 6 from EU partner universities, 3 from local partner universities and the remaining 2 reviewers from YU.

**3. External Review**

Most of the reviewers indicated that the course description, grading policy, teaching methodology, syllabus, text book are adequate. All of them indicated that the course contributes effectively to overall curriculum. Most of them recommended the inclusion of the course in the core curriculum. The following were indicated as the major strength and weaknesses with regard to course contents, course description and syllabus:

***Strengths***

1. The course provide an appropriate MSc level material
2. It provides the student with good background in wireless communication which will help the students in understanding advance topics in wireless networks.
3. High research level of the course topics. It will help the student in their thesis work.
4. The course contributes effectively to the overall core curriculum.
5. Semester project is good assessment.

***Weaknesses***

1. Course objective are too general and too brief
2. The listed text book and references are considered to be old, published between 1995 and 2005.
3. Assessment material is not enough, more information is needed
4. Important topics such as multiple access techniques, OFDM, performance of IEEE 802.11 and IEEE 802 should be covered.
5. Lack of studying wireless communication systems and standards such as GSM, GPRS, UMTS and LTE.
6. Lacks of practical aspects in the methodology
7. No lab sessions
8. Some overlap with CME 616
9. The lack use of Matlab and simulation within the course material.

#### **4. Internal review**

Two reviewers from YU filled the review form. They indicated that the course that is very important to the program since it gives the background material for other courses. One of them indicated that some issues hinder the achievement of the course objectives. These can be summarized as follow:

- The poor background of students in prerequisite topics and advance math did not help the instructor to fully cover the topics as described by the course syllabus.
- The weak background of the student in Matlab simulation made course project not very efficient.

They recommended the following:

- The student should have strong background in advance math
- More orientation toward project work should be considered
- More focus on computer simulation which will enhanced the understanding of the course as well as make the project more efficient.
- The student should study CME 652 before studying this course.
- The inclusion of this course in the core curriculum.

#### ***Recommendations***

The following remarks/ recommendation were indicated to improve the course module:

1. Most of the reviewers recommended the inclusion of the course in core curriculum. However some material should be added which is related to access techniques and wireless systems. Furthermore, impact of wireless transmission on everyday mobile applications to be added.
2. Most of the reviewer recommended more focusing on simulation and project work
3. One of the reviewers recommended changing the title to be Mobile communication techniques while other one recommended changing the title to wireless communications.
4. References and text book should be updated and should contain the latest technology in mobile communications.
5. More detailed in course syllabus should be included
6. More emphasis should be considered on practical components
7. Sequence of the course chapters should be changed. For example multipath channel should be located in chapter 2 before propagation model and cellular concept should be located after chapter 5.

## 5. Statistics

**Table 1 Professors review**

#	Question	Yes	NO	N/A
1	Is the title of the course appropriate and informative?	9	2	0
2	Does the course syllabus include the minimum information?	11	0	0
3	Are the course syllabus changes needed?	5	6	
4	Does the course provide an effective orientation module?	10	0	1
5	Are the course materials, teaching tools and text book relevant to the course and appropriate for learning the course objective?	11	0	0
6	Are there any course(s) in the program with complementary, related or overlapping content with this course?	3	8	0
7	Are there important topics or areas of expertise that are not adequately covered?	2	8	1
8	Are the requirements (prerequisite, course) appropriate for high quality program?	10	1	0
9	Is the grading policy for this course adequate?	9	2	0
10	Are the employed teaching methodologies adequate?	10	1	0
11	Does your institute offer a similar course?	6	0	5
12	Does this course contribute effectively to overall curriculum	11	0	0
13	Do you recommend the inclusion of this course in core curriculum?	8	0	3

**B. 8 CME 659: Advanced Wireless Networks****Tempus Project No. 511074****Work Package No.1****Deliverable No.1****Review of the Existing Curriculum****Individual Course-Review****Course Title: Advanced Wireless Networks CME 659****Prepared by****Dr. Haythem Bany Salameh****30/3/2011****1. Introduction**

This report includes summary and analysis of the collected reviews regarding the Advanced Wireless Networks (CME 659) course. The reviews (questionnaires) were completed by a number of professors (from EU and Jordan) and a number of students (current MSc students). Specifically, this report highlights the major strengths and weaknesses of this course and farther provides recommendations that would help improving this course.

**2. Target Reviewers**

The review form consists of 15 questions that measures the structure, content, description, syllabus, teaching methods used in this course. It also measures the relevancy of this course to the overall program. The course was reviewed by 10 professors (6 from EU, and 4 from Jordan) and 9 YU MSc students.

**3. Review Outcome**

Most of the reviews indicate that the course description, syllabus, course material, references, prerequisites, teaching methodology and grading policies are appropriate. The majority of the reviews recommend that the course title should be changed to Wireless Network. The reviews also state that this course contribute effectively to the overall master program, and consequently should be added to the core courses. Some reviews recommend that CME 656-Mobile Communication Systems, CME

638- Antennas, Propagation and Diversity, CME 652- Advanced Digital Communications should be added to the prerequisites' list.

### ***Strengths***

1. High research level of the course topics, course evaluation procedure, semester project proposal based on analytical or simulation work.
2. Topics provide an appropriate Master level course.
3. Good project marking structure.
4. The course includes Up-to-date technology and provides students with the sense of research and implementation of wireless concepts.
5. Course description, syllabus, course material, references, prerequisites, teaching methodology and grading policies are reasonably appropriate.
6. Most of the students expressed general satisfaction about the course, its contents and teaching methodology in particular. They indicated that this course is the most important course in the curriculum.

### ***Weaknesses***

1. Course title is not appropriate.
2. Prerequisites are not specified.
3. Course topics are very general and not sufficiently specified.
4. Course topics are involved for student to study in a 3 hour credit module.
5. The course topics do not include the number of hours.
6. Major parts of the references/books are relatively out-dated (published since 2002).
7. Some information mentioned in the data catalog e.g. Bluetooth, WAP, wireless ATM are not listed in the course topics.
8. QOS/QOt performance of applications in mobile and wireless environments is missing.
9. Network simulation packages are not included into this class.
10. Final exam is not described and the weight of in-class exams (40%) considerably low compared to the semester project (30%).

### ***Recommendations:***

1. This course should be an introductory course to wireless network since most of the students do not have a networking background.
2. The title of this course should be changed to Wireless Networks and this course should be included in the core curriculum. An advanced course in wireless networking should be proposed and added to the elective ones.
3. The following prerequisite courses should be considered: CME 656-Mobile Communication Systems, CME 638- Antennas, Propagation and Diversity, CME 652- Advanced Digital Communications. In addition, an introductory course to computer networks and algorithms are also needed.
4. Course topics/description need to be more descriptive rather than listing down all the topics. Course topics need to be carefully specified and should be broken down into several subsections and add the number of hours corresponding to each topic.

5. The topics may need to be cut down to fit a 3 hour credit module.
6. The course topics should include the number of hours needed to deliver the objectives of the course (equivalency with ECTS).
7. The course topics need to be continuously updated. Newer reference books may need to be recommended.
8. Course objectives need to be more specific & details describing the technical skills and knowledge to be learnt.
9. For understanding the wireless networks standards (IEEE 802.11, IEEE 802.16, UWB MB-OFDM, etc), MAC protocols, OFDM techniques, etc, should be covered in this course.
10. Since MIMO is sufficiently studied in CME 656-Mobile Communication Systems, Directional Antennas is covered in CME 638-Antennas, Propagations and Diversity, these topics should be removed from this course.
11. Simulation software is needed to implement different wireless protocol in order for students to better understand the concept of the different wireless protocols. Hence, a wireless network simulation lab is highly recommended to be included as a part of this course.
12. Students are expected to use too Matlab and NS2, it may be better focusing on one of them.
13. Exams should be given more weight.

#### 4. Review statistics for Advanced Wireless Networks CME 659 course

**Table I: Expert Review**

No.	Question	Yes	No	N/A
1	Is the title of the course appropriate and informative?	8	2	
2	Does the course syllabus include the minimum information?	*		
3	Are course syllabus changes needed?	*		
4	Does this course provide an effective orientation module?	*		
5	Are course materials, teaching tools, and text book relevant to the course and appropriate for learning the course objectives?	*		
6	Are there any course(s) in the program with complementary, related or overlapping content with this course?	*		
7	Are there important topics or areas of expertise that are not adequately covered?			
8	Are the requirements (prerequisites, courses) appropriate for a high quality program?		*	
9	Is the grading policy for this course adequate?		*	
10	Are the employed teaching methodologies adequate?	*		
11	Does your institute offer a similar course?	*		
12	Does this course contribute effectively to overall core curriculum?	*		
13	Do you recommend continuance (inclusion) of this course in core curriculum?	*		

**Table II: Student Review**

No.	Question	Yes	No	N/A
1	Is the title of the course appropriate and informative?	8	1	
2	Does the course syllabus include the minimum information?	*		
3	Are course syllabus changes needed?	*		
4	Does this course provide an effective orientation module?	*		
5	Are course materials, teaching tools, and text book relevant to the course and appropriate for learning course objectives?	*		
6	Are there any course(s) in the program with complementary, related or overlapping content with this course?	*		
7	Are there important topics or areas of expertise that are not adequately covered?			
8	Are the requirements (prerequisites, courses) appropriate for a high quality program?		*	
9	Is the grading policy for this course adequate?		*	
10	Are the employed teaching methodologies adequate?	*		
11	Does your institute offer a similar course?	*		
12	Does this course contribute effectively to overall core curriculum?	*		
13	Do you recommend continuance (inclusion) of this course in core curriculum?	*		

## Appendix C

### Reviews Questionnaires

#### Form A: Curriculum Review Form-Local Partners

**Reviewer's name &  
title:** \_\_\_\_\_

1. Are the admission requirements for the program appropriate?  Yes  No  N/A.  
Please provide comments/suggestions:

2. Are the provided course descriptions informative and complete?  Yes  No  N/A.  
Please provide comments/suggestions:

3. Do the current offered courses give solid knowledge in wireless communications?  
 Yes  No  N/A. Please provide comments/suggestions:

4. Does the current curriculum provide the graduates with enough knowledge and skills for  
future competitive and changing markets?  Yes  No  N/A. Please provide  
comments/suggestions:

5. Does the reviewer see any redundancy in the program courses?  Yes  No  N/A.  
Please provide comments/suggestions:

6. Does the program provide the students with strong analytical background for continued formal education at the doctoral level?  Yes  No  N/A. Please provide comments/suggestions:

7. Is the current master program based on industry defined needs?  Yes  No  N/A. Please provide comments/suggestions:

8. Do the current master courses contribute effectively to an overall master program in wireless communications?  Yes  No  N/A. Please provide comments/suggestions:

9. Does the reviewer recommend any new courses to be included in the core curriculum?  Yes  No  N/A. Please provide comments/suggestions:

10. Does the reviewer recommend any new courses to be removed from the core curriculum?  Yes  No  N/A. Please provide comments/suggestions:

11. Do the course syllabi need any improvement?  Yes  No  N/A. Please provide comments/suggestions:

12. Does the curriculum use appropriate and sufficient instructional methods?  Yes  No  N/A. Please provide comments/suggestions:

13. Does the reviewer recommend any additional teaching-aid methods or tools?

Yes  No  N/A. Please provide comments/suggestions:

14. Does the reviewer recommend any laboratory-based courses?  Yes  No  N/A.

Please provide comments/suggestions:

15. Does the current courses evaluation method measure the intended course objectives?

Yes  No  N/A. Please provide comments/suggestions:

16. Is the current master degree program flexible enough to provide students with the possibility of enrolling in a joint or multiple degree programs?  Yes  No  N/A.

Please provide any comments:

17. Is the current number of students in the master program comparable to the number of students in a similar master program offered at your institute?  Yes  No  N/A.

Please provide any comments

18. In your view, please list the major strengths in the existing program.

19. In your view, please list the major weaknesses in the existing program.

20. Based on your review, please provide us with any final recommendations in order to improve the current master degree program.

**Form B: Curriculum Review Form-Local Industry**

**Reviewer's name &  
title:** \_\_\_\_\_

1. Is the current master degree program based totally on theoretical teaching?  
\_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_. Please provide comments/suggestions:

2. Are the program courses relevant to your organization? \_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_.  
Please provide comments/suggestions:

3. Based on your review of the current master degree program, with regard to the current tools, facilities, and laboratories used, are they relevant to your organization? \_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_.  
Please provide comments/suggestions:

4. Does the current master program provide graduates with skills necessary for industrial research programs? \_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_. Please provide comments/suggestions:

5. Does the master program follow the rapid development in communication industry?  
\_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_. Please provide comments/suggestions:

6. Do the existing curriculum technical contents enhance the employability of graduates at your organization? \_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_. Please provide comments/suggestions:

7. In your view, what is the best approach for measuring the relevance of the program to the needs of local industry? \_\_Yes\_\_No\_\_N/A. Please provide comments/suggestions:

8. In your opinion, can the current program adequately prepare its graduates to be productive in your organization without further additional training? \_\_Yes\_\_No\_\_N/A.  
Please provide comments/suggestions:

9. Compared with job seekers, who do not possess a master degree, can the current program improve their employability rate at your company? \_\_Yes\_\_No\_\_N/A.  
Please provide comments/suggestions:

10. Does the current program prepare its graduates to take leading positions in local and regional communication industry? \_\_Yes\_\_No\_\_N/A. Please provide comments/suggestions:

11. In your view, are there any additional important technical issues that you recommend to include, which are of great interest to your organization?

12. In your view, what are the most important skills that graduating master students should possess to perform their job successfully at your organization?

13. Please, list the major strengths in the existing program.

14. Please, list the major weaknesses in the existing program.

15. Please provide any further comments and recommendations regarding the program.

**Form C: Curriculum Review Form-EU Partners**

**Reviewer's name &  
title:** \_\_\_\_\_

1. Are the admission requirements for the program appropriate? \_\_\_Yes\_\_\_No\_\_\_N/A.  
Please provide comments/suggestions:

2. Are the provided course descriptions informative and complete? \_\_\_Yes\_\_\_No\_\_\_N/A.  
Please provide comments/suggestions:

3. Do the current offered courses give solid knowledge in wireless communications?  
\_\_\_Yes\_\_\_No\_\_\_N/A. Please provide comments/suggestions:

4. Does the current curriculum provide the graduates with enough knowledge and skills for  
future competitive and changing markets? \_\_\_Yes\_\_\_No\_\_\_N/A. Please provide  
comments/suggestions:

5. Does the reviewer see any redundancy in the program courses? \_\_\_Yes\_\_\_No\_\_\_N/A.  
Please provide comments/suggestions:

6. Do the current master courses contribute effectively to an overall master program in  
wireless? \_\_\_Yes\_\_\_No\_\_\_N/A. Please provide comments/suggestions:

7. Does the reviewer recommend any new courses to be included in the core curriculum?  
\_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_. Please provide comments/suggestions:

8. Does the reviewer recommend any new courses to be removed from the core curriculum?  
\_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_. Please provide comments/suggestions:

9. Do the course syllabi need improvements? \_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_.  
Please provide comments/suggestions:

10. Does the curriculum use appropriate and sufficient instructional methods?  
\_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_. Please provide suggestions for additional teaching-aid methods or  
tools:

11. Does the reviewer recommend any laboratory-based courses? \_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_.  
Please provide comments/suggestions:

12. Is the current master program recognized for admission in PhD program by higher  
education institutions in EU? \_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_. Please provide any  
comments/suggestions:

13. Is the current master degree program flexible enough to provide students with the possibility  
of enrolling in a joint or multiple degree programs? \_\_Yes\_\_ \_\_No\_\_ \_\_N/A\_\_. Please provide  
any comments:

14. Is the current number of students in the master program comparable to the number of students in a typical EU master program? \_\_\_Yes\_\_\_No\_\_\_N/A Please provide any comments

15. Are the current teaching material/methods used in the master program inline with the teaching material/methods used in EU similar programs? \_\_\_Yes\_\_\_No\_\_\_N/A. Please provide any comments:

16. Are the current program/course assessment methods used in our college inline with EU standards? \_\_\_Yes\_\_\_No\_\_\_N/A. Please provide any comments:

17. Are the courses relevant to the needs of industry in EU? \_\_\_Yes\_\_\_No\_\_\_N/A  
Please provide any comments:

18. Does the current program include methods that enable a quality assurance of the graduates? \_\_\_Yes\_\_\_No\_\_\_N/A. Please provide any comments:

19. Is the current master program requirements comparable with those used in EU universities? \_\_\_Yes\_\_\_No\_\_\_N/A. Are there any changes that you would recommend for the program to have similar and equivalent requirements:

20. Is the current master program compliant with the European three cycle system using the (ECTS)? \_\_\_Yes\_\_\_No\_\_\_N/A. If not, can it be reconstructed to comply with ECTS, How?

21. Is it possible for our students to transfer course credit hours into the current ECTS system? \_\_\_Yes\_\_\_No\_\_\_N/A. Please provide any comments:

22. How do you rate this master program in comparison with similar EU programs?

23. In your view, please list the major weaknesses in the existing program.

24. In your view, please list the major strengths in the existing program.

25. Please provide comments and recommendations regarding the program as a whole.