JIM2L MS Program in Mechatronics:
Quality Control and Program Assessment

DRAFT ONE

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JIM2L MS Degree Program Assessment

1. Introduction

The purpose of this document is to specify the objectives of the double-degree MS program in Mechatronics and establish its assessment criteria. This MS program is part of the JIM2L “Development of International MS Degree and Life Long Learning Framework in Mechatronics” TEMPUS Project #51668.

The JIM2L program involves seven universities: Bochum University of Applied Sciences, Germany; Philadelphia University, Jordan; German Jordanian University, Jordan; London South Bank University, GB; Silesian University of Technology, Poland; Zagazig University, Egypt; Higher Technology Institute, Egypt; Heliopolis University, Egypt. All these universities are committed to continuously improve the quality of their Mechatronics programs. Therefore, it is important to develop and implement a formal plan to measure, assess, evaluate and improve their program in a systematic way.

Assessment is the systematic collection and analysis of information to improve student learning. Program assessment focuses on assessing student learning and experience to determine whether students have acquired the skills, knowledge, and competencies associated with their focuses on assessing student learning program of study [1]. The development of this assessment plan should begin with establishing the program mission and goals and students’ learning outcomes. These expected outcomes should describe the skills necessary for successful modern engineering practice. The program assessment and improvement process should involve both indirect and direct measures of the success of each course as well as overall measures of the educational program and of the assessment process itself. The overall success of a program is measured by whether the students of that program can demonstrate achievement the required outcomes when they graduate.

The program assessment can be divided into the following four cyclic phases [2]: Plan, Do, Check, and Act. This document is mainly concerned with the first phase (i.e. planning). Section 2 defines the mission and goals, Section 3 defines the learning outcomes, and Section 4 selects the assessment methods to be used. The other three phases are concerned with collecting/analyzing the data and implementing/monitoring changes and are mentioned briefly in Section 4.
2. Program Mission and Goals

The curriculum design includes a comprehensive set of courses, research, development, and training in the fields of industrial mechatronics, advanced robotic systems, embedded systems, advanced measurement systems and sensors, controllers and control algorithms, and mechatronics systems in modern state-of-the-art applications. All of these are supported with the needed mathematical, modeling, simulation, and computer-programming principles.

THE MISSION NEEDS TO BE AGREED UPON BY THE STEERING COMMITTEE

The JIM2L Masters’ degree mission is stated as follows: To cooperate among partner universities and international academic, research, and professional bodies towards sustaining dynamic International-Standard Master Degree of Sciences in Mechatronics, which equips its students with the skills necessary to excel professionally within the engineering discipline of Mechatronics and its complements in a global world.

The primary goals of the program are OPTION 1 (Simple and straight forward):

- To prepare engineers with up-to-date and modern engineering systems.
- To conduct applied scientific research in the field of mechatronic engineering.
- To contribute actively in transferring state-of-the-art technology.
- To provide valuable consultation and technical support to the industry.

The primary goals of the program are OPTION 2 (more in-depth and fancy words):

- To provide industry with highly trained engineers having interdisciplinary skills necessary to deal with state of the art tools in design, development and advancing of modern engineering systems.
- To develop graduates confident in addressing open-ended problems and who possess an attitude of self-learning.
- To develop appropriate skills of modeling and simulation of modern integrated engineering products, thus enabling participants to carry out the design and development of ‘smart’ products.
- To apply the latest techniques in precision mechanical engineering, control theory, computer science and engineering, and electronics to the design process to create more functional, adaptable, and cost effective products

THE ABOVE GOALS WERE SET BY PU, BUT THEY NEED TO BE REVIEWED AND AGREED UPON BY THE STEERING COMMITTEE

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The distinctive features of the program curriculum are:

**THIS PART IS NOT AN ESSENTIAL PART OF THE ASSESSMENT PLAN AND CAN BE OMITTED**

- The collaboration in research among different universities in order to build networks and serve the global engineering needs.
- The emphasis of engineering as a creative discipline in which mechanical, electrical, computer, and control systems are integrated in a parallel design approach in order to solve practical problems faced by societies.
- The Mastering of critical thinking that underlies problem definition, modeling, simulation, implementation, and verification as iterative design steps and derived from an in-depth understanding of the physical and mathematical sciences.
- The Educational experiences in which engineers learn the implementation of integrated systems and products.

3. **Students Learning Outcomes (SLOs)**

SLOs should be Specific, Measurable, Attainable, Results-oriented and Time-bound (SMART). The SLOs can be divided into: Knowledge and Understanding (K), Intellectual Qualities (I), Professional Skills (P), and Transferable Skills (T).

The program provides opportunities for students to achieve and demonstrate the following learning outcomes (i.e. program objectives):

**NOTE: SLO MUST BE RELATED TO PROGRAM GOALS (SEE APPENDIX B)**

**NOTE: THE FOLLOWING OUTCOMES ARE A MODIFIED SUMMARY OF JIM2L SYLLABI**

**Knowledge and Understanding (K)**

**K1** Understand analytical mathematical principles and computational models necessary to solve complex engineering problems.

**K2** Recognize the use of modeling, identification, and simulation concepts and tools needed to analyze integrated engineering systems.

**K3** Classify and describe systems that use different controllers, sensors, automation, and robotic elements.
K4 Comprehend advanced programming concepts as they relate to different embedded systems and their uses in control.

K5 Understand the design requirements and problem solving steps that are required to solve open-ended research problems.

K6 Demonstrate a comprehensive understanding of the scientific principles of mechatronic engineering as they relate to electronic, mechanical, control, and software engineering.

Intellectual Qualities (I)

I1 Formulate strategies and design solutions to advanced engineering problems by selecting appropriate mathematical, modeling, and programming tools to analyze complex systems.

I2 Demonstrate an understanding of engineering principles and use them to design integrated systems by selecting and interfacing the appropriate sub-systems and components.

I3 Classify and describe the performance of mechatronic systems and components by conducting appropriate experiments to collect, analyze, and interpret data to form reliable conclusions.

I4 Generate novel designs for mechatronic products, systems and/or processes by conducting systematic research to investigate latest technologies to fulfill requirements.

Professional Skills (P)

P1 Select and apply the appropriate system design development tools and available software in order to simulate industrial and mechatronic systems to find optimal solutions and designs.

P2 Manage and implement research projects by gathering, organizing, and analyzing technical literature in order to explore and test novel methods within a specified time period.

P3 Plan and conduct laboratory tasks by using a variety of equipment and systems.

P4 Demonstrate an awareness of intellectual property, appropriate codes of practice and industry standards.

Transferable Skills (T)

T1 Function effectively as a member of a team and provide leadership in work groups and projects.

T2 Communicate effectively through written and oral work.
Exercise planning, organizational, problem-solving, and time-management skills and effectively use available resources.

Adapt research and development to achieve optimal technical solutions taking into account available cutting-edge technology.

Work for lifelong self-learning by using information technology and gathering on-hand experience.

4. Assessment Methods

The program’s mission and objectives have been defined in the previous sections. In this section, the process for program evaluation is presented. Program evaluation is usually conducted for the following program elements: Curriculum, students, faculty, and resources.

- **Curriculum**: How the curriculum accomplishes the program objectives?
- **Students**: How the student demonstrates course outcomes?
- **Faculty**: How are the faculty interacting and motivating students to be more creative?
- **Resources**: How are resources serving program needs?

As shown in section 3, the SLOs were divided into four categories: Knowledge, Intellectual, Practical, and Transferable. The assessment methods for each category are listed below:

- **Knowledge and Understanding**
  Assessment is achieved through examinations, assignments, laboratory reports, project dissertation and oral presentations.

- **Intellectual Skills**
  Assessment is achieved through assignments, experimental write-ups and project reports. Some of these skills are also assessed in the formal examinations.

- **Practical Skills**
  Assessment is achieved with visits, reports and an oral presentation, assignments, workshop exercises, laboratory reports and project dissertations.

- **Transferable Skills**
  Assessment is achieved through assignments, laboratory reports and project dissertations. Assessment of teamwork is achieved through submission of teamwork tasks, student peer and self-assessment, and oral presentations.
4.1 Direct vs. Indirect Methods

The program assessment methods are composed of different measurement tools that will be used to assess whether the SLOs were achieved or not. These measurements can be divided into two parts: direct measure and indirect measure.

Direct measurements evaluate the competence of students in the program while indirect measurements are mainly concerned with students’ experiences, opinions, or perceptions, rather than their knowledge and skills. A collection of direct and indirect measurements are shown in Table I.

Table I. Assessment Tools

<table>
<thead>
<tr>
<th>Direct Assessment</th>
<th>Indirect Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Written Exams</td>
<td>Course portfolio (syllabus, textbook, course material, exam samples and website information)</td>
</tr>
<tr>
<td>Course Projects</td>
<td>Course Grade Distribution</td>
</tr>
<tr>
<td>Course Homework</td>
<td>Course Ratings and Students’ Feedback</td>
</tr>
<tr>
<td>Student Presentations</td>
<td>Employment Placement Rates</td>
</tr>
<tr>
<td>Thesis Report</td>
<td>Graduation Data</td>
</tr>
<tr>
<td>Thesis Defense</td>
<td>Focus Groups and Open Discussions</td>
</tr>
<tr>
<td>Exit/Comprehensive Exams</td>
<td>Exit interviews</td>
</tr>
<tr>
<td>Certification Exams and Standardized Tests</td>
<td>Surveys</td>
</tr>
<tr>
<td>Internships</td>
<td>Professional Meetings with Faculty and Graduates</td>
</tr>
<tr>
<td>Student Portfolio (collection of student work samples)</td>
<td>Industry Feedback Regarding Graduate Performances (workshops, seminars, questionnaires)</td>
</tr>
</tbody>
</table>

NOTE THAT WE SHOULD DEVELOP ASSESSMENT TEMPLATES (SUCH AS THE ONES SHOWN IN APPENDIX C) AND FILL THEM OUT SO THAT WE CAN MAP EACH OUTCOME TO THE APROPRIATE ASSESSMENT METHOD

4.2 Data Collection and Analysis

The curriculum is composed of courses which were designed to insure that all of the program outcomes are demonstrated throughout the student studies. Student materials should be collected from these courses to provide evidence that the outcomes have been achieved. The materials should be reviewed and evaluated by the department to establish whether the students in that class have achieved some or all of the program outcomes. Modifications should be proposed, implemented, and monitored in the semester to follow.

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At the end of each semester, students and faculty members should rate each course and see if it achieved its objectives. The faculty member should identify the program outcome(s) as related to his/her course and provide evidence that the objectives were achieved. In addition, students and faculty are encouraged to comment on how well the course fits into the overall scheme of the program and to suggest improvements to the course, the course outcomes and the overall program of study. A faculty meeting is held at the beginning of each semester to review all evaluations from the prior semester and develop any needed plan for improvement.

All actions taken at each step of the assessment process will be documented in an assessment database. The Chair of the department will update this database every time action is taken in the assessment process, and will solicit for improvements to the assessment process. In this way, a written record will be kept of both the assessment activities and of the process itself. This record will be used by the faculty to evaluate and improve the assessment process.

**THIS SECTION SHOULD BE EXPANDED: THE DATA COLLECTION AND ANALYSIS SHOULD BE MORE ELABORATIVE**

In order to implement the proposed assessment procedure, the following actions are required by the department:

- Oversee all changes to the Program and be responsible for its design and effective delivery.
- Bring forward any issues raised by the student groups, evaluations, and questionnaires.
- Evaluate the content and delivery of each module.
- Maintain an industrial advisory board which it consults on changes to its provision to ensure excellent industrial relevance.
- Review all programs, each year, to ensure their effectiveness and identify opportunities for improvement.

5. Conclusion

This document proposed an assessment criteria and process for the JIM2L double-degree MS in Mechatronics Program. First, the Program’s mission and goals were set. Then, the Student Learning Outcomes were gathered and summarized. It is important to link those outcomes with the Program’s goals and to verify that these outcomes are covered in courses’ syllabi.
Assessment methods include direct and indirect measurements. These measurements compliment each other and they should be used as combinations to measure the specified SLOs. The process for data collection and analysis should be clearly set with a well-explained mechanism to follow. It is crucial to have a feedback process were the analyzed data is used in a pre-defined time schedule to enhance and improve the Program.

References:

Appendix A: Flow Chart for the Assessment Process [2]

Step 1: Organize for assessment

Step 2: Define program mission

Step 3: Define program goals

Step 4: Define program student learning outcomes

Step 5: Inventory existing and needed assessment methods

Step 6: Identify assessment methods and targets for each learning outcome

Step 7: Collect the Data

Step 8: Analyze Results

Step 9: Provide feedback

Step 10: Implement Changes

Step 11: Monitor changes and compare results

Step 12: Review information
## Appendix B: GOALS AND OUTCOMES

<table>
<thead>
<tr>
<th>Goal 1</th>
<th>Goal 2</th>
<th>Goal 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome 1</td>
<td>Outcome 3</td>
<td>Outcome 8</td>
</tr>
<tr>
<td>Outcome 2</td>
<td>Outcome 4</td>
<td>Outcome 9</td>
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<td></td>
<td>Outcome 5</td>
<td>Outcome 10</td>
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<td>Outcome 6</td>
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<td></td>
<td>Outcome 7</td>
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</tbody>
</table>
### Curriculum Evaluation

<table>
<thead>
<tr>
<th>Intended Learning Outcome</th>
<th>Curricular and/or Co-Curricular Experiences</th>
<th>Method(s) of Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>What will students know or be able to do upon completion of the program?</td>
<td>Where will students acquire the skills and/or knowledge identified in the outcome?</td>
<td>How will you determine that the students know or can do what you expect?</td>
</tr>
<tr>
<td><em>Measurable statement of the desired output or what students should know, think, or be able to do upon completion of the program.</em></td>
<td>Course(s) and/or experience(s) through which students will acquire the skills and/or knowledge identified in the outcome and what level of learning students are expected to attain, i.e., basic, intermediate, or advanced.</td>
<td>Methods of assessment must address the outcome directly and identify who will be responsible for implementing the assessment measure, what data will be collected, and when the data will be collected and analyzed.</td>
</tr>
</tbody>
</table>

### Student Evaluation

<table>
<thead>
<tr>
<th>Stated Objective or Performance</th>
<th>Beginning</th>
<th>Developing</th>
<th>Accomplished</th>
<th>Exemplary</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stated Objective or Performance</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Description of identifiable performance characteristics reflecting a beginning level of performance.</td>
<td>Description of identifiable performance characteristics reflecting development and movement toward mastery of performance.</td>
<td>Description of identifiable performance characteristics reflecting mastery of performance.</td>
<td>Description of identifiable performance characteristics reflecting the highest level of performance.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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