Analysis of Twelve Electrical and Electronics Engineering Programs

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***Abstract**: This paper investigates undergraduate programs in electrical and electronics engineering offered by twelve universities in Australia, Asia, Europe, and America. The investigation focuses on the structure and content of the programs, and the contact hour and assessment of the subjects involved in the programs. The investigation is carried out in four stages: selection of universities, collection of data, analysis of data, and formulation of outcomes. A list of subjects is created based on the content of the programs. The average percentage coverage of each subject in the twelve programs is calculated. The subjects are then grouped into nine program components. The average percentage coverage of each component per university is calculated. For each component, the total number of contact hours for lecture, tutorial, and practical is calculated. Also, the average percentage of four assessment methods for each component is found. Discussions on the outcome of the investigation are presented.*

Introduction

According to a number of recent employment surveys (Ong, 2009), engineers continue to be in high demand in Australia with some variations among disciplines. However, the emergence of green economy and the need for creating a sustainable future for Australia are stimulating modernisation and workforce development in key engineering disciplines. Electrical and Electronics Engineering (EEE) has been a dynamic, demanding and fast changing discipline in present engineering. The field forms a key pillar of the products and services related to energy efficiency, renewable and clean energy sources, energy production, smart grid, and life and environment quality.

To educate for a sustainable future, address the needs of the green economy, and ensure the effectiveness of the engineering courses, the School of Engineering at Deakin University is planning to devise a modern undergraduate curriculum in Electrical and Electronics Engineering. An important first step in formulating the curriculum is to investigate and analyse the EEE curricula across several varying-tier national and internal universities. Investigations of some engineering curricula in different universities can be found in the literature (Lee, et al., 2008; Memon, 2007; Mouthaan, Brink, & Vos, 2002; Shepstone, 2009; Toral, Martinez-Torres, Barrero, Gallardo, & Duran, 2007).

In this paper, the structure and content of undergraduate programs in EEE offered by twelve national and international universities from Australia, Asia, Europe, and America are investigated, and analysed. The investigation focuses on the structure and content of the programs, and also the contact hour and assessment of the subjects covered in programs. The collected data, as well as the analysis results and associated discussions are reported. The outcome of this research is the identification of cohesion and uniformity in EEE programs delivered in various countries.

Methodology

The analysis of the EEE curricula is carried out in four stages: (i) selection of universities, (ii) collection of data, (iii) analysis of data, and (iv) formulation of outcomes. In the first stage, a set of universities offering undergraduate programs in EEE in Australia, Asia, Europe, and America is selected. In the second stage, the data associated with the EEE curricula offered in the selected universities is collected from the official websites of each university, or if unavailable, by contacting the relevant authority in the associated university. In the third stage, the collected data is analysed by

formulating the main components of the EEE programs offered in the selected universities, and then carrying out four investigations including subject, program, contact-hour, and assessment based analysis. Based on the outcome of the first three stages, further investigation is performed to devise the outcome on the structure of an EEE program.

Universities used for analysis

To ensure that a good mixture of data is collected and that the data is comprehensive and meaningful, a total of twelve national and international universities from among different tier universities are selected. To identify and select the appropriate universities that offer EEE programs, and that fall into different university tiers, many more universities and their engineering offerings are investigated. The investigation is carried out by using the universities respective websites, catalogues available publically, or alternatively through direct contact with relevant authorities in the associated university.

The twelve selected universities are from Australia, Asia, Europe, and America. Six universities are selected from Australia, three from U.K., one from Singapore, and two from U.S. For the two U.S. universities, we selected their electrical engineering common subjects, and then included the subjects from their electronics specialism. For the three U.K. universities, we included their four-year length program. Table 1 provides a list of the twelve universities selected for this research work.

Table 1. Universities selected for analysis of EEE programs.

No	Name of University	Abbreviation	No	Name of University	Abbreviation
1	University of Adelaide	UA	7	Bristol University	BU
2	Flinders University	FU	8	University College London	UCL
3	James Cook University	JCU	9	University of Leeds	UL
4	RMIT University	RMIT	10	Nanyang Technology University	NTU
5	Swinburne University of Technology	SUT	11	Michigan State University	MSU
6	University of Western Australia	UWA	12	University of California, Los Angeles	UCLA

Subject-based analysis

After the selection of the twelve universities, the structure and content of the undergraduate EEE programs offered by the universities are investigated. The subjects covered in each program and their contents are examined using the information collected from the universities websites, catalogues, etc. All identified subjects are compared among the twelve programs. Overall, a list of 54 subjects is assembled based on the subjects found in the twelve programs. First, the subjects that are common among multiple programs are identified. Next, the remaining subjects are specified.

After identifying the subject among the twelve universities, the percentage coverage of the content of each subject in each program is calculated. A table is formed that includes 54 rows and 12 columns. For each subject, the value in a column represents the percentage coverage of the content of the subject in a specific university. Next, the average percentage coverage of each subject among all twelve universities is calculated and recorded. Figure 1 shows the list of the 54 identified subjects among the twelve universities, and also the average percentage coverage of each subject.

As can be seen from the figure, the subjects with higher average percentage coverage appear in the undergraduate EEE programs of more universities than those with lower average percentage coverage. This information can be used in the selection of subjects for a new EEE program where the subjects with higher average percentage coverage could be selected first. Then, depending on the objectives of the program, the remaining subjects could be chosen from among the list of subjects with lower average percentage coverage.

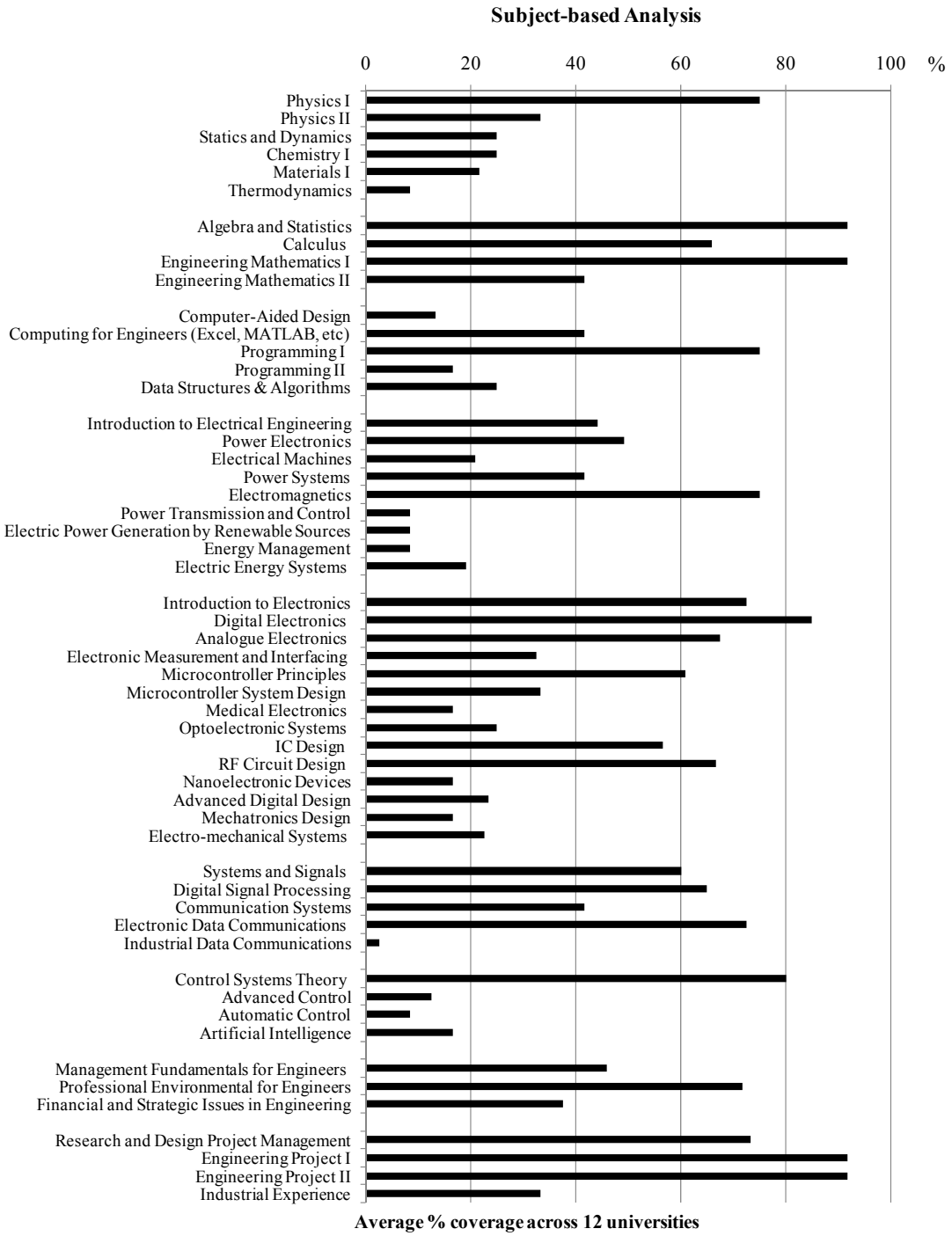

Figure 1. List of the 54 identified subjects among the twelve universities, and the average percentage coverage of each subject in the twelve programs.

Components of electrical and electronics engineering program

The 54 identified subjects offered in the twelve EEE programs are next grouped into nine components. The groups are devised to identify the extent of EEE program and the range of different subjects that could be offered in a new EEE program. The grouping exercise is not a straightforward task because of the variation in the program structures as well as subjects across the examined programs in different universities. Figure 2 shows the components of the undergraduate EEE programs in the twelve universities. The list of the subjects belonging to each group can be seen in Figure 1. The subjects belonging to different groups are separated using a blank line. For example, the first six subjects belong to Group 1, and the last four subjects belong to Group 9.

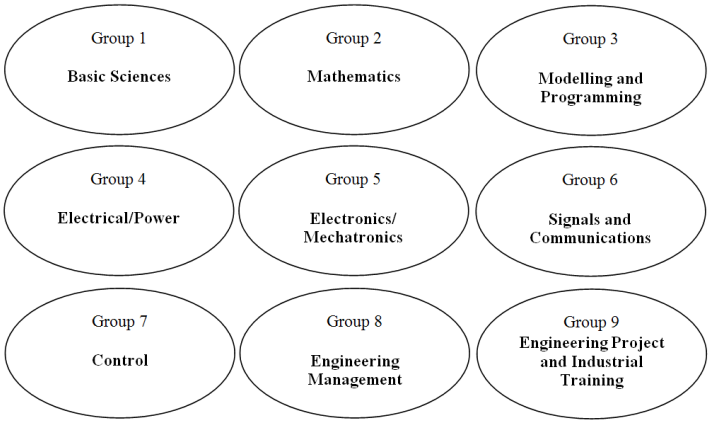

Figure 2. Components of undergraduate EEE programs in twelve universities.

Program-based analysis

To aid the comparability of the components of the twelve different undergraduate EEE programs, the breakup of each programme into the nine identified components is performed. To identify the extent of coverage of each program component in the twelve universities, based on the average percentage coverage of the subject within each component, the average percentage coverage of each component per university is calculated. Figure 3 shows the average percentage coverage of components per university.

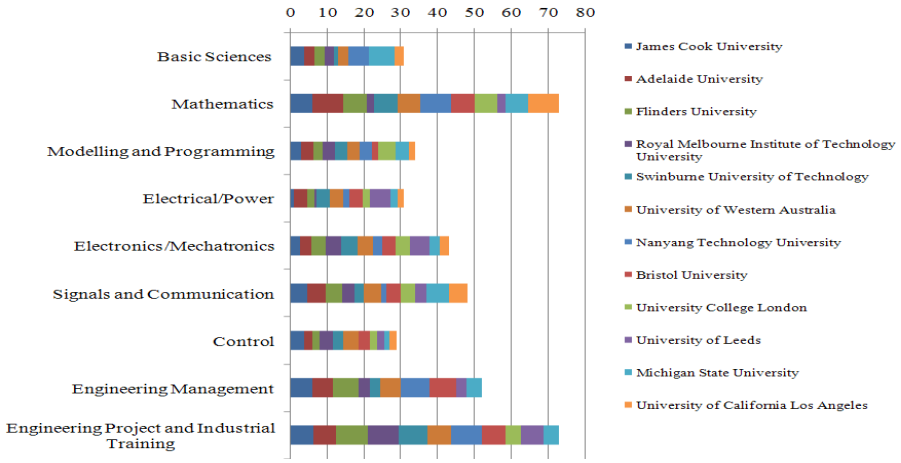

Figure 3. Average percentage coverage for each program component in different universities.

Contact-hour-based analysis

The twelve EEE programs are studied and the teaching methods for different subjects across the twelve universities are identified. A range of different approaches are identified in teaching of subjects depending on the content of the subject, the year of offer, the program, and the university. Three common teaching methods are determined: lecture, tutorial, and practical. The lecture provides a context on which the subject is built. The lecture sequence that is presented by a lecturer builds a story about the subject and delivers it to students. The tutorials give students an opportunity to receive individual attention, feedback, advice and suggestions from a tutor. The students get a chance to actively engage with the unit content, assess their own progress, and get to know other students. Practicals give students an opportunity to try out their development skills and assess their own progress. Some subjects are found to include a major project. In this work, the project work is also listed under the practical for simplicity.

For each of the nine program components, the total number of respective contact hours for lecture, tutorial, and practical are calculated. Figure 4 illustrates the overall average contact hours per program component for a teaching semester among the twelve universities.

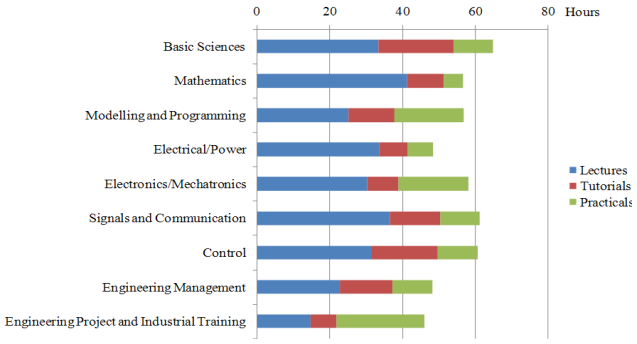

Figure 4. Overall semester average contact hours per program component among the twelve universities.

Assessment-based analysis

Depending on the subject, program structure, and university, the 54 identified subjects are evaluated in a number of different ways in the twelve universities. Four common assessment methods are determined: assignment, test/quiz, lab/project, and examination.

The assignment requires the student to work outside of the contact hours of the subject to finish an assessment. Students are permitted to use any material to aid in the completion of the assessment. The test/quiz assesses students either in an unsupervised or a supervised manner while they complete a small set of questions. The lab/project assesses students' practical skills where they carry out hands-on experiments or a major project. The exam assesses students in a supervised manner while they complete a comprehensive set of questions about various aspects of the subject they have learnt. Figure 5 displays the average percentage of the four assessment methods for each nine program component among the twelve universities.

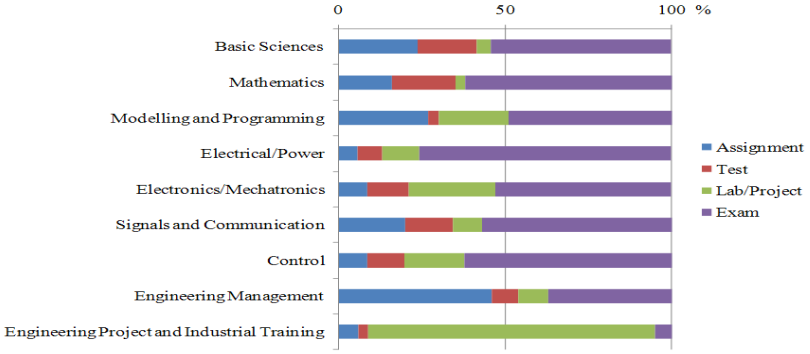

Figure 5. Average percentage of the four assessment methods for each nine program component among the twelve universities

Recommendations

To devise a curriculum for an undergraduate EEE program, the programs in EEE offered by several varying-tier universities were studied. The investigation focused on the structure, content, contact hour, and assessment of the subjects covered in the EEE programs. A list of 54 subjects was assembled based on the subjects found in the twelve programs. The average percentage coverage of the content of each subject in each twelve program was calculated. As shown in Figure 1, several subjects achieved average percentage coverage of greater than 70%. These include Physics I, Engineering Mathematics I, Programming I, Digital Electronics, Control System and Theory, and Project Management, and Engineering project.

To support the comparability of the structure of the twelve different undergraduate EEE programs, the 54 identified subjects were then grouped into nine components as shown in Figure 2. The average percentage coverage of each component per university was calculated and shown in Figure 3. As can be seen from the figure, Mathematics, Engineering Project, Engineering Management, and Signals and Communication components were covered in the EEE program of more universities.

For each of the nine program components, the total number of contact hours for lecture, tutorial, and practical were calculated and displayed in Figure 4. As can be seen from the figure, the Mathematics component had more lecture than practical hours, whilst the Modelling and Programming component had more practical than lecture hours in comparison with the Mathematics component. Also, the average contact hours for the Basic Science component was the largest, whilst the Engineering Project component had the least average contact hours.

Four common assessment methods were identified among the twelve universities. The average percentage of the four assessment methods for each program component was calculated and shown in Figure 5. As can be seen from the figure, apart from Engineering Management and Engineering Project, the other seven components had a major final examination. The lab/project assessment of the Basic Sciences and Mathematics components were very small, but their tutorial assessment was the largest among the nine program components. The assignment assessment varied among the nine components, where Engineering Management showed the largest assignment assessment among the others.

The main outcome of this research is the identification of cohesion in the EEE programs delivered in various countries as shown in the presented figures in the paper. This information would facilitate the development of a new curriculum in EEE. For the selection of subjects for a new EEE program, the subjects with higher average percentage coverage could be selected first. Then, depending on the objectives of the new program, the remaining subjects could be chosen from among the list of subjects with lower average percentage coverage. In the same manner, the contact hours and assessments can be devised for each subject using the information presented in the paper.

Conclusions

The School of Engineering at Deakin University is planning to introduce a modern undergraduate curriculum in Electrical and Electronics Engineering. The paper investigated the structure and content of undergraduate programs in EEE in twelve varying-tier universities. The main outcome of the work is the determination and presentation of uniformity in the examined EEE programs. For the selection of subjects for the new EEE program, the subjects with higher average percentage coverage can be selected. Then, based on the objectives of the new program, the remaining subjects are chosen from among the list of subjects with lower average percentage coverage. Moreover, the contact hours and assessment methods are devised for each subject using the information presented in the paper.

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