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The Correlation of University of Guyana Engineering Students' Performance in Engineering Mathematics Course and Other Engineering Core Courses in Mechanical and Civil Engineering Programs

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***Abstract*— It is widely believed by lecturers and professors in Engineering that to complete a Bachelor's of Engineering or a Bachelor's of Science degree, students must excel in Engineering Mathematics at the University level. The notion is that students that grasps Engineering Mathematics concepts, theory and application to engineering disciplines such as Mechanical and Civil, with this strong foundation, should translate to a strong performance in engineering core intense calculation courses. Currently, there is limited research that can validates this assumption.**

***Students who completed their Mechanical and Civil Engineering Bachelor's degree in 2024 academic profile was analyzed to determine the relationship between their performance in Engineering Mathematics year 3 which is year 1 of the Bachelors since at the University of Guyana Engineering Program is a 2+2, 2 years for the Associate degree and another 2 years for the Bachelor's degree. Their Engineering Mathematics grades and scores where correlated with performances in core calculation courses in Mechanical Engineering such as Applied Thermodynamics, Theory of Machines and Strength of Materials, and Civil Engineering Course Structural Analysis. All the courses are in semester 1 in year 3.**

The spearman's rank correlation coefficient showed that there is a moderate positive correlation between Engineering Mathematics (EMT 3100) performance/grade and Strength of Materials (MEC 3108) performance/grade for Mechanical Engineering. However, Theory of Machines (MEC 3107) and Applied Thermodynamics (MEC 3106) when analyzed with EMT 3100, revealed no correlation. Furthermore, there is a weak negative correlation between EMT 3100 and Structural Analysis (CIV 3115)

***Index Terms*— Spearman's Correlation Coefficient, P values, Engineering Mathematics, Applied Thermodynamics, Theory of Machines, Strength of materials, Structural Analysis, Academic performance.**

I. INTRODUCTION

The Over the last decade, administrators and lecturers at the University of Guyana, Faculty of Engineering and Technology have voiced their concerns about the low performances in Engineering Mathematics courses in the Associate of Science and Bachelors of Science programs. The consensus is that students that achieve high marks in Engineering Mathematics courses will translate to strong performances in other core engineering courses in all programs. However, marksheets for Engineering Mathematics courses throughout the 4-year degree program, approximately 50% of students fail year 1 Mathematics, in years 2 and 3 the passing rate increases, however, the achievement of grade A by students is around 20%. It seems that the difficulty in understanding and applying the Mathematics knowledge, theory and concepts to other engineering courses such as Mechanical and Civil courses is a major hurdle proven by the high failure rates in these courses as well. According to Roselainy et. al. (2010), students generally struggle to comprehend and apply mathematics concepts and theory taught even though they work through multiple problems on a topic. Students feels that if they practice text book questions they now know the topic thoroughly, however, they find it difficult to cope if questions are slightly altered. When questions are modified for an exam, students do not conceptualize what is required to correctly solve them, they could not apply the techniques learned in the class room to the questions that are structured slightly differently. Importantly, lecturers realized that the issues students are coping with in Engineering Mathematics courses are showing up in various other engineering core courses in all the faculty programs [1]. Aziz et. al. (2012), argued that a deep approach over the surface approach method should be adopted for teaching at the first year of study. Lectures and administrators must take students perceptions and suggestions, use these to revised course curriculum, plan and develop systems that can integrate learning outcomes and instructional activities along with effective assessment procedures. This is vital since it will

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enable students to track the topics they are learning and will learn and their possible achievement after completing the courses. Therefore, the use of deep approach technique will lead to students have an increase appreciation for their studies, they will want to excel, enjoy their studies and increased involvement in their own learning [2]. Bischof et. al. (2015), stated that Mathematics knowledge leads to logical reasoning in the engineering discipline which is imperative for engineer's competency to function effectively and efficiently in the work environment [3]. Furthermore, Goold (2012) mentioned that developing appropriate Mathematical reasoning and thinking is more relevant to an engineer's work even though two thirds of engineers utilizes what they learnt from the curriculum for Engineering Mathematics courses in their field of work. Consequently, in any Engineering Program, Mathematics plays a pivotal role in an aspiring engineers studies, it is essential for studnets to learn, understand and apply all concepts in Mathematics and other core Engineering calculation courses [4]. As a result, this present work looks at the graduation class of 2024, Mechanical and Civil Engineering students who completed their Bachelor's degree in August 2024. Their academic profiles were reviewed, year 3 semester 1 Mathematics course performance was identified and compared with other core engineering courses in the Mechanical and Civil Engineering departments. This study was initiated because of the failure rates and poor performances in Engineering Mathematics courses in the Associate and Bachelors of Science programs.

II. METHODS AND METHODOLOGY

The quantitative methodology design was utilised for this study. It focuses on using objective measurements, numerical methods, and statistical methods when conducting data analysis [5]. Secondary data was used since it was graduating student's academic profiles that were studied, it means that the data existed and was gathered from secondary sources. Dunn etal. (2015) stated that utilising secondary data sources to answer research questions and to test hypothesis possess significant advantages. These advantages include acquiring data in a timely manner at a relatively low cost or no cost at all. In addition, it ensures access to large amount of data and data relating to time series without the need for participant's involvement [6].

The data studied in this research include Mechanical Engineering and Civil Engineering students who completed their Bachelor's Degree in the year 2024. Their academic profiles were accessed, the year 3 performances in Engineering Mathematics (EMT 3100) was evaluated against Applied Thermodynamics (MEC 3106), Theory of Machines (MEC 3107) and Strength of Materials (MEC 3108) for Mechanical Engineering program. In addition, Engineering Mathematics was evaluated against Structural Analysis (CIV 3115).

Microsoft Excel was used to analyzed the data. The Spearman's rank correlation coefficients and p values were calculated using descriptive analysis.

Grading scheme used at the University of Guyana, Faculty of Engineering and Technology

Table 1. Grading Scheme

Grade	Percentage	Description
A	75 - 100	Excellent
B	65 - 74	Good
C	55 - 64	Satisfactory
D	50 - 54	Sufficient
F	0 - 49	Fail

III. RESULTS & ANALYSIS

Correlation between Engineering Mathematics (EMT 3100) and Applied Thermodynamics (3106)

The correlation between Engineering Mathematics (EMT 3100) and Applied Thermodynamics (MEC 3106) year 3 Mechanical Engineering Bachelors of Science program students in the year 2024 was conducted. Spearman's Rank correlation coefficient was applied, the statistics obtained from Microsoft excel were, R = 0.43 and p value = 0.107. The R value and p value indicates that there is not a significant correlation between the 2 variables. In figure 1, the EMT 3100 scores are plotted against MEC 3106 scores. The data reveals that 7 (46.6%) students scored lower grades in EMT 3100 but achieved higher MEC 3106 grades, 2 (13.3%) students achieved a higher EMT 3100 grade and scored a lower MEC 3106 grade, 5 (33.3%) students scored grade A's for both courses and one student scored low grades for both courses, EMT 3100 (D) and for MEC 3106 (C) grade.

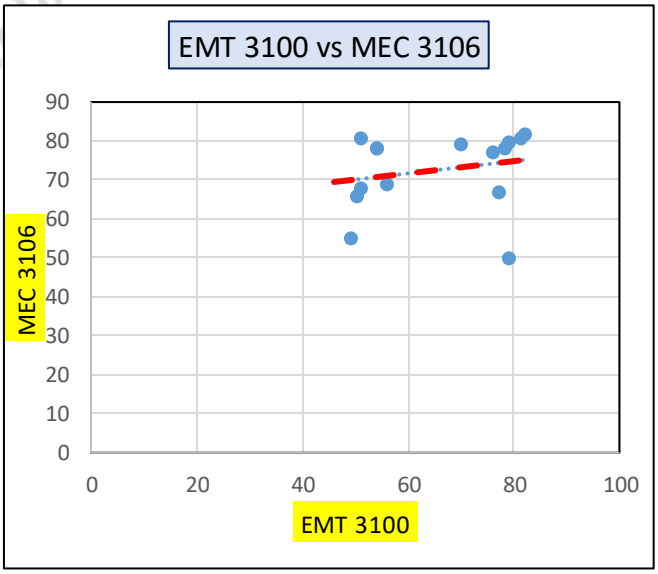

Figure 1(a). EMT 3100 scores vs MEC 3106

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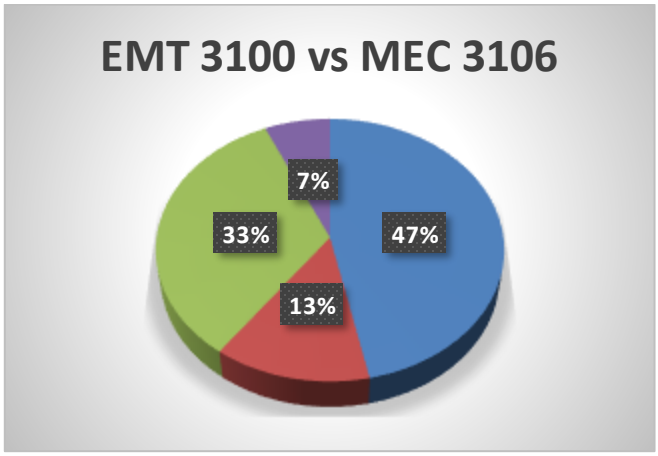

Figure 1(b). EMT 3100 and MEC 3106 scores distribution

Table 2. The R and P values for EMT 3100 and MEC 3106

Key Results	
R	0.43
N	15
P value (p > 0.05)	0.107

Correlation between Engineering Mathematics (EMT 3100) and Theory of Machines (3107)

The correlation between Engineering Mathematics (EMT 3100) and Theory of Machines (MEC 3107) year 3 Mechanical Engineering Bachelors of Science program students in the year 2024 was conducted. Spearman's Rank correlation coefficient was applied, the statistics obtained from Microsoft excel were, R = 0.12 and p value = 0.682. The R value and p value indicates that there is no correlation between the 2 variables. In figure 2, the EMT 3100 scores are plotted against MEC 3107 scores. The data reveals that 7 (46.6%) students scored lower grades in EMT 3100 but achieved higher MEC 3107 grades, 4 (26.7%) students achieved a higher EMT 3100 grade and scored a lower MEC 3107 grade and 4 (26.7%) students scored grade A's for both courses.

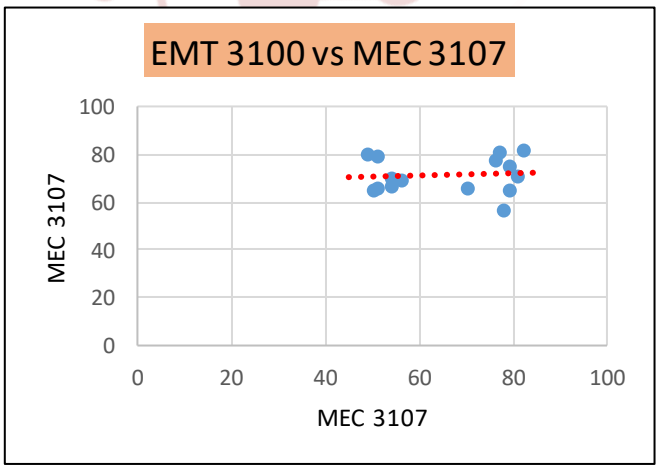

Figure 2(a). EMT 3100 scores vs MEC 3107

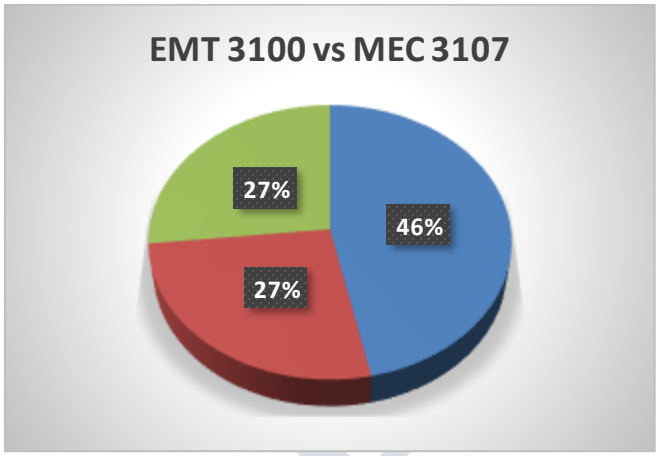

Figure 2(b). EMT 3100 and MEC 3107 scores distribution

Table 2. The R and P values for EMT 3100 and MEC 3107

Key Results	
R	0.12
N	15
P value (p > 0.05)	0.682

Correlation between Engineering Mathematics (EMT 3100) and Strength of Materials (3108)

The correlation between Engineering Mathematics (EMT 3100) and Strength of Materials (MEC 3108) year 3 Mechanical Engineering Bachelors of Science program students in the year 2024 was conducted. Spearman's Rank correlation coefficient was applied, the statistics obtained from Microsoft excel were, R = 0.55 and p value = 0.03. The R value and p value indicates that there is a moderate positive correlation between the 2 variables. In figure 3, the EMT 3100 scores are plotted against MEC 3108 scores. The data reveals that 3 (20%) students scored grade C's in EMT 3100 but achieved grade A's in MEC 3108, 3 (20%) students achieved higher grades in EMT 3100 (A's and B's) and scored a lower MEC 3108 grade (B's and C's), 1 (6.7%) student scored a grade D for EMT 3100 and achieved a grade B for MEC 3108. In Addition, 3(20%) students scored grade D's for EMT 3100 but scored grades C for MEC 3108, and 5(33.3%) achieved grades A for both courses.

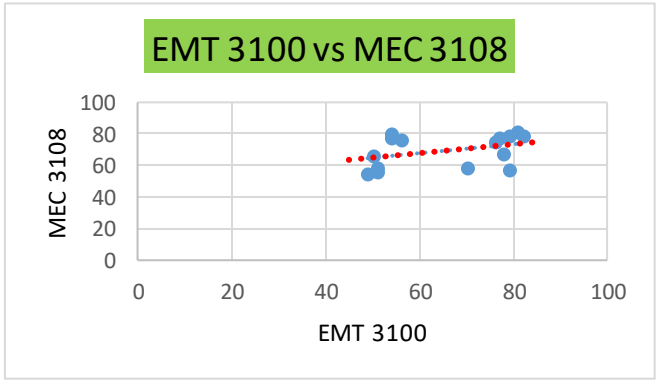

Figure 3(a). EMT 3100 scores vs MEC 3108

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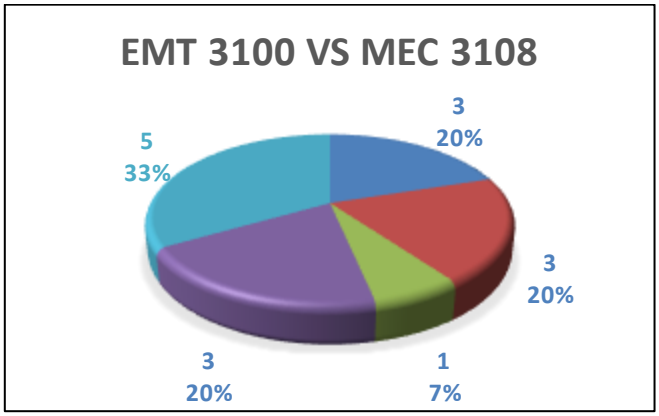

Figure 3(b). EMT 3100 and MEC 3108 scores distribution

Table 3. The R and P values for EMT 3100 and MEC 3108

Key Results	
R	0.55
N	15
P value ($p < 0.05$)	0.03

Correlation between Engineering Mathematics (EMT 3100) and Structural Analysis (CIV 3115)

The correlation between Engineering Mathematics (EMT 3100) and Structural Analysis (CIV 3115) year 3 Civil Engineering Bachelors of Science program students in the year 2024 was conducted. Spearman's Rank correlation coefficient was applied, the statistics obtained from Microsoft excel were, R = -0.0283 and p value = 0.895. The R value and p value indicates that there is not a significant correlation between the 2 variables. In figure 1, the EMT 3100 scores are plotted against MEC 3106 scores. The data reveals that 7 (29.2%) students scored lower grades in EMT 3100 but achieved higher CIV 3115 grades, 14 (58.3%) students achieved a higher EMT 3100 grade and scored a lower CIV 3115 grade and 3 (12.5%) students scored the same grades for both courses.

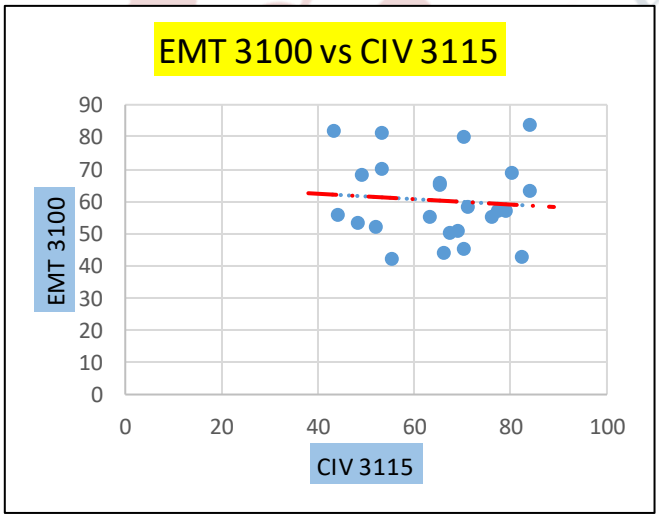

Figure 4(a). EMT 3100 scores vs CIV 3115

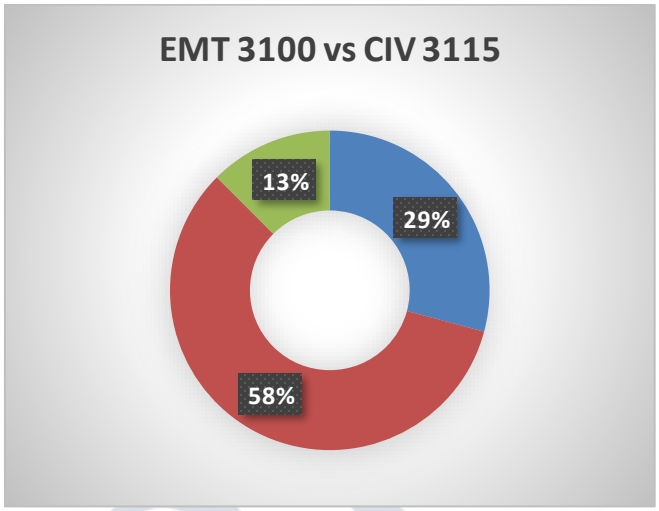

Figure 4(b). EMT 3100 and MEC 3108 scores distribution

Table 4. The R and P values for EMT 3100 and CIV 3115

Key Results	
R	-0.0283
N	24
P value ($p > 0.05$)	0.895

IV. IMPLICATION OF FINDINGS / RECOMMENDATIONS

According to Roselainy et. al. (2010), students generally struggle to comprehend and apply mathematics concepts and theory taught even though they work through multiple problems on a topic. Students feels that if they practice text book questions they now know the topic thoroughly, however, they find it difficult to cope if questions are slightly altered. Furthermore, Aziz et. al. (2012), argued that a deep approach over the surface approach method should be adopted for teaching at the first year of study. Lectures and administrators must take students perceptions and suggestions, use these to revised course curriculum, plan and develop systems that can integrate learning outcomes and instructional activities along with effective assessment procedures.

The analysis conducted for Engineering Mathematics course performance and Engineering courses in Mechanical and Civil departments is of significant importance, it will enable the administration to implement measures that can give students the best opportunities to perform better in these courses. The spearman's rank correlation coefficient indicates that there is no significant positive relationship between engineering mathematics course and core courses in mechanical and civil engineering programs in the Bachelors of Science program. One exception is Engineering Mathematics and Strength of Materials where R = 0.58 and $p < 0.05$ which suggest that a low performance in Engineering Mathematics will result in a low performance in Strength of Materials and an excellent performance in engineering

mathematics course will lead to an excellent performance in strength of materials course. The Faculty of Engineering and Technology at the University of Guyana can administer Mathematics diagnostic tests throughout the Associate and Bachelors Engineering programs to determine student's Mathematics comprehension and interpretation skills, application of formula, derivation of formula and practical problems worked. The results will guide Heads of Departments on implementing measures such as added tutorials, laboratory work to reinforced theory taught in class, using software to solve Mathematical problems, provide detailed solutions to example questions and have students engage in class to solve problems in groups and work them out on the black/white board. In addition, design and implement summer Mathematics specific courses to target core skills that students are lacking in the Engineering Mathematics field. Similarly, these same strategies can be adopted for the core Engineering courses in Mechanical and Civil Engineering programs such as Applied Thermodynamics, Theory of Machines, Strength of Materials and Structural Analysis.

V. CONCLUSION

The spearman's rank correlation coefficient indicates that there is no significant positive or negative relationship between Engineering Mathematics course performance and performances in core courses in Mechanical and Civil Engineering programs in the Bachelors of Science program. One exception is Engineering Mathematics (EMT 3100) and Strength of Materials (MEC 3108) where $R = 0.58$ and $p < 0.05$ which suggest that a low performance in Engineering Mathematics will result in a low performance in Strength of Materials and an excellent performance in Engineering Mathematics course will lead to an excellent performance in Strength of Materials course. The statistics suggest that there is a moderate relationship between EMT 3100 and MEC 3108. Another exception is that the correlation between Engineering Mathematics (EMT 3100) and Structural Analysis (CIV 3115) shows that Spearman's Rank correlation coefficient $R = -0.0283$ and p value = 0.895. The R value and p value indicates that there is not a significant correlation between the 2 variables. This analysis is the only one with a negative relationship, it indicates that as students perform better in EMT 3100 the statistic reveals that the performance decrease in CIV 3115.

Conflict of Interest:

The author declares that there is no conflict of interest.

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