Challenges in Curriculum Adaptation across Institutions of Higher Education:
Similarities between International and National Student Transfer

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Abstract – **The challenges associated with student transfer between institutions of higher education are investigated. The Utah System of Higher Education (USHE) requires that undergraduate courses from non-ABET accredited institutions are recognized across public universities and colleges in Utah. Based on empirical data, we show that as a result, curriculum development now has to take place across institutions. As a first step, to maintain academic standards in this changing environment, before granted major status in Electrical Engineering, we propose an admissions test for all students. In addition, undergraduate student performance could be continuously monitored, similar to the monitoring process of international graduate students. Typically, the change in academic environment for students also includes the transition from a more personal to a more anonymous setting. Thus, we propose the creation of a "transfer student academic advisory" position – similar to an international advisor - in all colleges across Utah. Our research is a first step towards the goal of achieving unified engineering programs across institutions.**

I. INTRODUCTION

Typically, student transfer in higher education occurs at the bachelor's level, leading into a master's or PhD degree. In addition, recently there has been a steady increase in student transfer at the undergraduate level from community colleges to state universities in Utah. Naturally, curriculum development in higher education is approached as an integral and challenging process, which needs to be constantly monitored, optimized and adapted to a changing professional environment. One important part in this process is quality assessment. As a result of the international nature of graduate education and the qualitative differences between institutions and degrees, some common academic standards have been created. Traditionally, on the graduate level, standardized tests such as the GRE are used (along with other indicators) to estimate future student performance. While quality assessment on the graduate level is challenging, on the undergraduate (Junior or Senior year) level, no standardized tests exist. As an example, the Utah System of Higher Education (USHE), which consists of 10 public colleges and universities, requires transparency between institutions of higher education. The USHE guarantees that undergraduate courses numbered 1000 or above will be recognized across public universities and colleges in Utah. Under these circumstances, a single institution alone can no longer independently control the undergraduate curriculum development process.

In this paper, we investigate the challenges in curriculum development in a changing, integrated undergraduate environment. We show that striking and significant similarities exist between the situation of international graduate and national undergraduate level transfer students. Using data obtained at the Electrical and Computer Engineering department at the University of Utah (UofU), we present methods to evaluate and assess student performance at the time of transfer and the time of graduation.

In contrast to the transition at the graduate level, the transition period for undergraduate students is typically very short, and the change is abrupt. To ease the transition period and prepare transfer students for the challenges in their new academic environment, we suggest the creation of a "transfer student academic advisory" position – similar to an international advisor - in all institutions of higher education throughout Utah. We emphasize that any mismatch between the curricula of different institutions can significantly affect the success of the educational process, especially if the transfer occurred late in the undergraduate program. We highlight the importance of curriculum development across colleges, optimally at the state level. We also motivate the introduction of admission tests for major status, in effect comparable to the standardized SAT or GRE.

As a result of our investigations, a stronger contact between the faculty at the Department of Electrical and Computer Engineering at the University of Utah and the Engineering Department at the Salt Lake Community College (SLCC) has been established. Our research is a first step towards the goal of achieving unified engineering programs across institutions.

The paper is organized as follows: first we present our objective and then give an overview of SLCC and UofU undergraduate student performance. Our assessment is based on an evaluation of transfer and native UofU students based on junior level classes as well as on student GPA upon program completion. In the next step, we show that similarities exist between national undergraduate to (international) student transfer on the graduate level. As a result, we propose to apply similar solutions to the case of national undergraduate student transfer to sustain academic standards.

II. STUDENT TRANSFER AT THE UNDERGRADUATE LEVEL – STATEMENT OF PROBLEM

Currently, in the ECE Department of the UofU, students may apply for major status during any semester in which they complete a set of required classes, see [APPENDIX 1]. The current GPA for admission to major status is 2.8 on the classes listed, except for ECE 1020 and Cp Sc 1010 in which CREDIT is required. This GPA, however, does not guarantee admission. The maximum number of students admitted per year is capped at 75 in accordance with ECE program resources. Transfer students from ABET engineering accredited schools (USU, BYU for instance) will be admitted under the same criteria as UofU students. With the emergence of the USHE program, public colleges in Utah are required to accept transfer credit from other non-ABET accredited public colleges, where technical transfer classes with grades below C- and technology classes are not accepted in the UofU Electrical Engineering program, see [APPENDIX 2] for the list of articulated classes. Transfer students from non-ABET accredited schools (such as SLCC, Weber, Snow, etc.) will be provisionally admitted if they meet the above criteria. After completion of 21 hours of UofU or other accredited technical classes with a GPA of at least 2.8, transfer students from non-accredited schools can apply for full major status [1]. In other words, transfer students from non-accredited institutions are currently put on probation. As a result of the transfer, by their junior year, the composition of students' classes has become very inhomogeneous.

III. A COMPARISON BETWEEN GRADES FROM UNACCREDITED INSTITUTIONS TO THE UNIVERSITY OF UTAH

Figure 1 presents an overview of the formation of classes for 69 students who graduated from the ECE department with their BSEE between Summer 2003 and Spring 2004. In the figure, we show the number of classes transferred from non-ABET accredited institutions (red number below the lines), the GPA of these classes (the heart symbol) and the range of grades (the dotted, red vertical lines) as well as the GPA of the classes taken by the same students at the UofU (black dots) and its range (black solid lines). The comparison in Figure 1 was performed at the beginning of the junior year and only included classes mentioned in [APPENDIX3]. As can be seen, the number of transferred courses varies between 0 and 9 out of the total of 10 classes used for the comparison. In fact, while 24 students did not transfer any classes, the remaining 43 transferred an average of 3.37 classes. While this is not problematic in and of itself, it is striking that the grades in the transferred classes (red hearts) are often about one full grade point higher than the grades earned at the UofU (black dots). Unfortunately, as we will see, the higher grades may be linked to grade inflation. Another interesting observation is that the students are sorted from left to right according to their final GPA at graduation (students on the left had the highest graduation GPA as noted in Figure 2), however their GPA at the time of admission show some of this trend but was not a clear a predictor of final graduation GPA. The grades at the unaccredited institutions are not used in the calculation of graduation GPA per department policy.

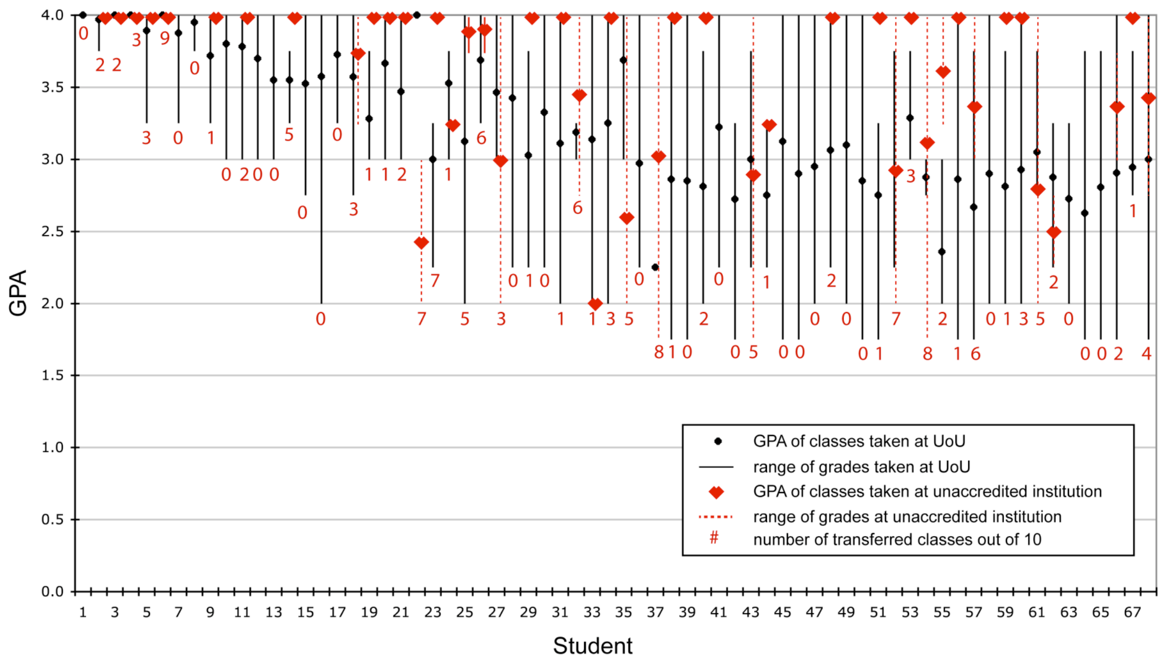

Figure 1: *Comparison of grades from non-ABET accredited institutions to grades earned at the ECE department of the University of Utah at the junior level.*

Figure 2 includes the GPA at the time of graduation with the BSEE for the same students, and we see that the same discrepancy still exists. In other words, students *tend to be evaluated too optimistically at unaccredited institutions compared to at the ECE department at the UofU.* This observation now raises several concerns.

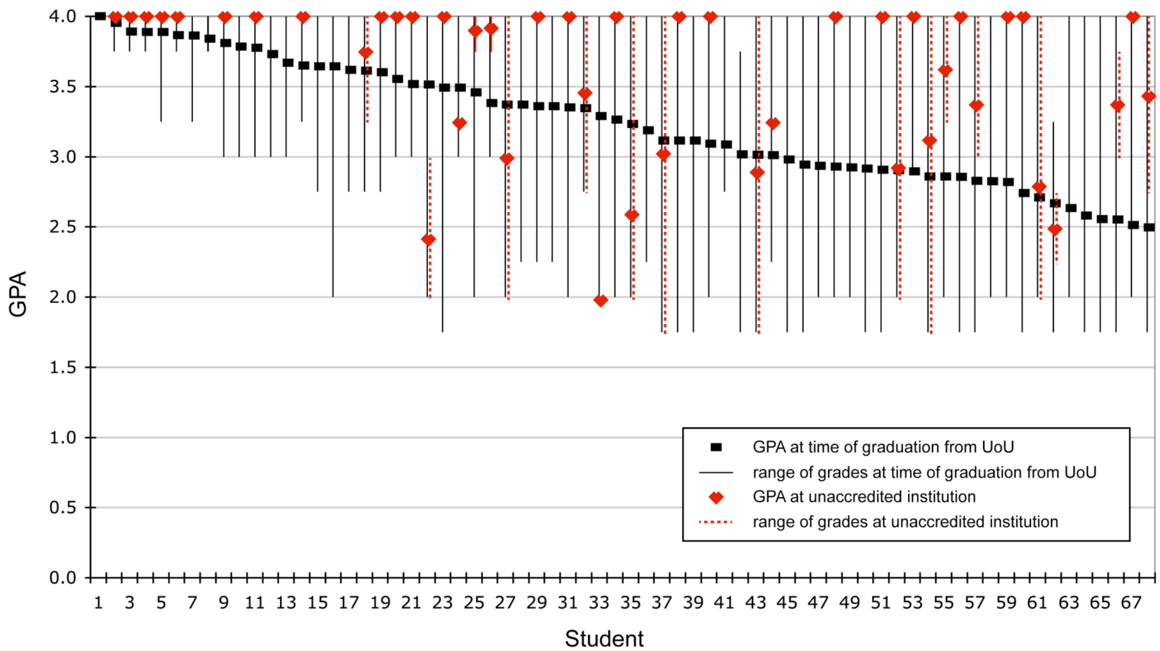

Figure 2: *GPA at time of Graduation with BSEE from ECE department at University of Utah. Identical students as used for Fig. 1*

A. Fairness concerns

Since the GPA of the transferred classes for most students is significantly higher than the GPA earned at the UofU, students who transfer a large number of classes have a definite advantage over their peers in the admission process. However, the transfer grades are not used when calculating the graduation GPA. Students have claimed that the earlier classes were easier to obtain high grades in, so not being able to include those early class grades in their final GPA puts them at a disadvantage at graduation. Obviously, this raises fairness concerns and may lead to discomfort among the student body.

B. Sustaining academic standards – problems with grading on the curve

From our teaching experience, we feel that discrepancies exist between the materials taught at some of the non-accredited institutions compared to the UofU. This is problematic when teaching courses for which this background is prerequisite and especially delicate when fairness is considered. One possible reason hypothesized for the difference in grading may lie in the vastly different student body at the UofU compared to neighboring non-ABET accredited institutions. Freshmen students at the UofU are competitively selected based on SAT and high school GPA, and admission requirements are lower for neighboring unaccredited institutions. Students often choose the community colleges if their previous academic performance is insufficient to be admitted to the accredited schools. Another very common reason for this choice is that the tuition is lower at community colleges, which will be more attractive to students from families with less money or students who are working to support themselves while attending college. Both of these choices indicate well-known risk factors for lower academic performance. The significant difference in student demographics leads to measurably different student performance statistics. The common "grading curve" could be expected to yield different outcomes for these different student bodies. Respective to their peers, the curve still distinguishes between good-medium-poor performance, but when the grades are transferred, they do not necessarily provide an accurate comparison between two different student bodies. This may explain the discrepancies observed in Figure 1 and underlined in Figure 2. Here, we see that throughout their undergraduate career, students with weaker performance on the early admission classes (native UofU as well as transfer students) typically remain low in class ranking. This observation, while not at all surprising, only strengthens the concerns outlined in Section III-A. Students may profit from the different performance statistics at non-accredited institutions and could specifically choose the community colleges, because "they are easier." While this is not exactly an exemplary reason, it is quite understandable given the financial incentive to complete an engineering degree. While it might be nice to have a unified performance metric when assessing transfer grades, this is quite difficult in practice. Grading on the curve can be an important tool in the teaching process, and instructors may not be willing to abandon it. Also, it may be very hard if not impossible to guarantee identical grading policies. Clearly, a more versatile tool for the evaluation of student performance is required. Standardized tests have been used to resolve this issue to some extent at the graduate level but have not been implemented here at the undergraduate level.

IV. SIMILARITIES BETWEEN NATIONAL UNDERGRADUATE AND INTERNATIONAL GRADUATE STUDENT TRANSFER

In essence, the challenges associated with student transfer on the undergraduate level are not novel to the academic community. In fact, in the US, institutions have been faced with the very same problem of determining the validity of grades in graduate education. In the case of graduate student transfer, a combination of students' transcripts, and GRE scores are typically used to estimate future performance. Another part of this process is additional information, which has been gathered over years – "black" and "white" lists – that rank the overseas schools and are used to "filter" the grades to some extent.

A. Possible Solutions: admissions test and performance monitoring

In other words, on the graduate level, transfer is a highly selective process and from the students' perspective rather unpredictable. This is very different from the case of undergraduate student transfer in Utah. Here, because of the USHE, student grades must be taken at face value. To manage this inherent non-uniformity, all undergraduate transfer students were put on probation until they had taken 21 credits at the UU with at least a 3.0 GPA. While this solution is comparable to the monitoring process of international graduate students, it was perceived as unfair, since it only affects transfer students. It was also extremely cumbersome, because many (part time) students took 3-4 semesters to obtain their 21 additional hours. Modifying this process to allow students with a GPA above 3.5 to transfer without probation has reduced these concerns somewhat.

Due to the difficulty of predicting graduation GPA (compare Figures 1 and 2), a common admission exam is recommended. This would not come without its own problems – what about students who just take the admission exam over and over until they receive a grade sufficient to be admitted, who would write/grade the exam, and what would it cover, how much time would the students need to allocate to study for a comprehensive exam across all subjects, and would it actually be more effective as a predictor of success at graduation. Furthermore, it is possible and recommended to extend the monitoring process to all ECE undergraduates.

V. UNDERGRADUATE ADVISING

A. Student Orientation

From student interviews, we know that the transition period for transfer students is abrupt, and adaptation to the new academic environment is challenging. As an example, at the SLCC class sizes are typically below 20 and more realistically around 10 students. This is very different from entry-level classes at the UofU, where class sizes are mostly between 60 and 100. As guidance, at the ECE department of the UoU, new freshman and transfer students are invited to attend one of the University's orientation sessions that mostly cover orientation to the campus and academic processes such as registering, getting a bus pass, and declaring a major. Prior to admission to the program (and afterwards if needed), students can visit a department academic advisor who helps them choose classes to stay on track to graduate. After students have been admitted to major status, an ECE faculty member is assigned as advisor. Students are encouraged to meet with their faculty advisor whenever necessary to discuss class scheduling plans, current academic issues, or other matters of concern. However, it is left to the student to request an appointment with her/his faculty advisor, and most do not. This situation is similar to the SLCC, where it is up to the students to ask their instructor about the possible impact of the new environment on their performance. From our previous discussions, it is clear that many students face significant adjustment challenges, and it may be necessary to utilize all possible methods of preparation much more carefully. In the case of international student transfer, in most countries, students are at least told about these academic challenges in their final year, and methods for coping are recommended. This typically goes along with preparation for language tests such as the TOEFL or S.P.E.A.K exam. As a result, while perfect preparation is surely impossible, students are more aware of the challenges ahead. Also, after international students join their new university, they are guided through a series of mandatory orientation events. Also, schools typically have a number of international advisors that are available for student consultation, and most international graduate students visit these advisors multiple times during their first year. Finally, international graduate student GPA is continuously monitored to ensure that they are meeting set minimal GPA requirements. These methods, no doubt coupled with significant student motivation, result in very low dropout rates and high student performance.

From this perspective - especially since the USHE seems to indicate a long-term commitment to integral education across institutions and colleges - we propose a similar system for national undergraduate transfer with advisors available at all institutions involved.

V. CONCLUSIONS

This paper discusses the challenges associated with student transfer from unaccredited t o accredited institutions of higher education in Utah. We show that curriculum development has to take place across institutions. Based on empirical data, we demonstrate that grades from non-ABET accredited institutions tend to be one full grade point higher than grades earned at the UoU. Since the higher grades may be linked to grade inflation at the non-accredited institutions, it raises issues of fairness and accurate prediction of future success in admission to major status. In order to increase overall student performance and maintain academic standards, we propose admissions testing for all students prior to when major status in Electrical Engineering is granted. In addition, undergraduate student performance could and probably should be continuously monitored, similar to the monitoring process of international graduate students. In addition, the change in academic environment for undergraduate students often includes the transition from a more personal to a more anonymous academic setting. Thus, we propose the creation of a "transfer student academic advisory" position – similar to an international advisor - in all institutions of higher education across Utah. Our research is a first step towards the goal of achieving unified assessment of students in engineering programs across institutions.

REFERENCES

[1] The Department of Electrical and Computer Engineering at the University of Utah, www.ece.utah.edu

APPENDIX 1:

CLASSES REQUIRED FOR MAJOR STATUS AT ECE DEPT. OF UNIVERSITY OF UTAH, FALL 2005

1. **ECE 1000 Introduction to Electrical and Computer Engineering.** The basics of analog circuits as an introduction to Electrical and Computer Engineering. Concepts of voltage, current, power, resistance, capacitance, and inductance. Circuit analysis techniques such as Kirchhoff's Laws, node voltages, and mesh currents. Thevenin's and Norton's equivalent circuits. Simple op-amp and timing circuits. Alternating current and impedance.
2. **ECE 1020 Electrical Engineering Problem Solving with MATLAB**. Introduction to the field of Electrical Engineering through programming in the Matlab language. Students design various components of a prototype communication system while learning about the following aspects of Matlab: script and function files, math functions, commands for array construction and manipulation, string expressions, logical operators, control flow, and graphics. No prior knowledge of Electrical Engineering is assumed.
3. **Cp Sc 2000 or 2010 Program Design in C or Introduction to Computer Science I**. Introduction to essential programming concepts using C. Decomposition of programs into functional units; control structures; fundamental data structures of C; recursion; dynamic memory management; low-level programming. Some exposure to C++. Laboratory practice. (Intended for non-CS/CE majors).
4. **Cp Sc 1010 Introduction to Unix.** An introduction to the Unix workstations used in the College of Engineering CADE Lab. Topics include the X Windows system, Unix shell commands, file system issues, text editing with Emacs, accessing the World Wide Web with Netscape, and electronic mail. Self-paced course using online teaching aids.
5. **Math 1210 or 1270 Calculus I or Accelerated Engineering Calculus I.** Functions and their graphs, differentiation of polynomial, rational and trigonometric functions. Velocity and acceleration. Geometric applications of the derivative, minimization and maximization problems, the indefinite integral, and an introduction to differential equations. The definite integral and the Fundamental Theorem of Calculus.
6. **Math 1220 or 1280, Calculus II or Accelerated Engineering Calculus II**. Geometric applications of the integral, logarithmic, and exponential functions, techniques of integration, conic sections, improper integrals, numerical approximation techniques, infinite series and power series expansions, differential equations (continued).
7. **Phys 2210 Physics for Scientists and Engineers I**. Designed to give science and engineering students a thorough understanding of the basic physical laws and their consequences. Classic mechanics will be introduced, including methods of energy, momentum, angular momentum, and Newtonian gravity. Applications include mechanical oscillations, sound, and wave motion.

APPENDIX 2:
ECE DEPT. TRANSFER ARTICULATION

ELECTRICAL ENGINEERING DEGREE -- TRANSFER ARTICULATION — October 2005

UNIVERSITY OF UTAH -- ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

U of U	SLCC	CEU	DIXIE	UVSC	SNOW	WEBER	SUU	USU	BYU	BYU ID	WESTMIN	LDS BC
FIRST YEAR - FALL SEMESTER												
Cp Sc 1010 (0.5) **Intro to Unix**	EE 1030	BCIS 2210	CS 1110	CNS 1510		CS 1130						
Cp Sc 2000 (4) or **Cp Sc 2010 (4)**	CS 1600	BCIS 1540	CS 1440	CNS 1350	CS 1410 & 1415	CS 1220	CS 1110	CS 1720	CS 142 & 235	CS 165	CMPT 202	
Math 1210 (4)* **Calculus I**	Math 1210	Math 1210	Math 1210	Math 1210	Math 1210	Math 1220	Math 1210	Math 1210	Math 112	Math 112	Math 201	Math 111
Chem 1210 (4) **General Chemistry**	Chem 1210	Chem 1210	Chem 1210	Chem 1210	Chem 1210	Chem 1210 Lab ilncl	Chem 1210	Chem 1210		Chem 105 or 105H	Chem 111	
Chem 1215 (1) **General Chem Lab**	Chem 1215	Chem 1230	Chem 1230	Chem 1230	Chem 1215		Chem 1220	Chem 1230			Chem 112	
Wrtg 2010 (3) **Academic Writing**	Engl 2010 or 2100	Engl 2010	Engl 2010	Engl 2010 or 2020	Engl 2010 or 2014		Engl 2010 & 3080	Engl 2010	Engl 115 or 200	Engl 211 or 211C	Engl 110	Eng 201
FIRST YEAR - SPRING SEMESTER												
ECE 1270 (4) **Intro to EE and CE**	EE 1270 (was 1100)			Engr 2750	Engr 2100 & 210L		Engr 3070 & 3080	ECE 2410 & 2420	ECEn 212	CompE 250		
ECE 1020 (1) **Intro to Matlab**	EE 1020											
Math 1220 (4)* **Calculus II**	Math 1220	Math 1220	Math 1220	Math 1220	Math 1220	Math 1220	Math 1220	Math 1220	Math 113	Math 113	Math 202	
Phys 2210 (4) **Phy for Sci & Engr I**	Phys 2210	Phys 2210	Phsx 2210	Phys 2210	Phys 2210	Phys 2210	Phys 2210	Phyx 2210	Phscs 121**	Ph 121**	Phys 211	
SECOND YEAR - FALL SEMESTER												
ECE 2270 (4) **Electric Circuits**	EE 2270 (was 2050)				Engr 2270 & 2275			ECE 3620	ECEn 212 & 313 & 317			
Math 2250 (3) **ODE & Linear Alg**	Math 2250	Math 2270 & 2280	Math 2270 & 2280	Math 2270 & 2280	Math 2270 & 2280	Math 2250	Math 3210 & 3440	Math 2250	Math 334 & 343	Math 341 & 371		
Phys 2220 (4) **Phy for Sci & Engr II**	Phys 2220	Phys 2220	Phsx 2220	Phys 2220	Phys 2220	Phys 2220	Phys 2220	Phyx 2220	Phscs 123** Phscs 220**	Ph 123** Ph 220**	Phys 212	
SECOND YEAR - SPRING SEMESTER												
ECE 2280 (4) **Engr Electronics**	EE 2280 (was 2100)			EEng 4760				ECE 3410	ECEn 313 & 317			
ECE/Cp Sc 3700 (4)*** **Digital Systems**	EE 2700 or CS 2610				Engr 2700 & 2710			ECE 2530 & 2540 or 5530	ECEn 224			
Math 2210 (3)* **Calculus III**	Math 2210	Math 2210	Math 2210	Math 2210	Math 2210	Math 2210	Math 2210	Math 2210	Math 214	Math 214	Math 303	

* Students who have an AP AB score of 3 or 4 or a Math ACT score of 30 should take Math 1270 and 1280. If 1270 and 1280 are taken, Math 2210 is not required..

** Three semesters of Physics at BYU and BYU Idaho are required to replace two semesters of Physics at the University of Utah.

*** Students who plan to take additional digital classes at the University of Utah should take ECE/Cp Sc 3700 at the University of Utah.

APPENDIX 3:
CLASSES USED FOR COMPARISON OF GRADES

1. **ECE 1000 Introduction to Electrical and Computer Engineering**. The basics of analog circuits as an introduction to Electrical and Computer Engineering. Concepts of voltage, current, power, resistance, capacitance, and inductance. Circuit analysis techniques such as Kirchhoff's Laws, node voltages, and mesh currents. Thevenin's and Norton's equivalent circuits. Simple op-amp and timing circuits. Alternating current and impedance.
2. **ECE 2000 Fundamentals of Electric Circuits**. Fundamental electric-circuit techniques, including Kirchhoff's laws, impedance, superposition, phasor transforms, RLC solutions in the time domain, sinusoidal steady-state systems, frequency response, filters, Fourier-series methods, Laplace-transform techniques, transformers.
3. **ECE 2100 Fundamentals of Engineering Electronics**. Fundamentals of electronic circuits and components, network models of amplifiers, basic semiconductor device physics, diodes, bipolar and MOS transistors, basic analog and digital circuit elements, frequency response, feedback and stability. Introduction to computer circuit simulation.
4. **PHYS 2200 Physics for Scientists and Engineers II.** The continuation of PHYCS 2210. Electrostatics, electric fields, and potential. Magnetic fields and Faraday's law. Current flow, resistance, capacitance and inductance. Electric circuits and electromagnetic oscillations. Electromagnetic waves, geometric and physical optics.
5. **PHYS 2210 Physics for Scientists and Engineers I.** Designed to give science and engineering students a thorough understanding of the basic physical laws and their consequences. Classic mechanics will be introduced, including methods of energy, momentum, angular momentum, and Newtonian gravity. Applications include mechanical oscillations, sound, and wave motion.
6. **ECE 3700 Fundamentals of Digital System Design**. Techniques for minimizing logic functions and designing common combinational circuits such as decoders, selectors, and adders. Synchronous and asynchronous sequential circuits, state diagrams, Mealy and Moore circuits, state minimization and assignment. Use of software tools for design, minimization, simulation, schematic capture. Implementation with MSI, LSI, and field programmable gate arrays. Laboratory included
7. **MATH 2210 Calculus III.** Vectors in the plane and in 3-space, differential calculus in several variables, integration and its applications in several variables, vector fields and line, surface, and volume integrals. Green's and Stokes' theorems.
8. **CS 2000 Introduction to Program Design in C**. Introduction to essential programming concepts using C. Decomposition of programs into functional units; control structures; fundamental data structures of C; recursion; dynamic memory management; low-level programming. Some exposure to C++. Laboratory practice. (Intended for non-CS/CE majors).

9. **MATH 1210 Calculus I**. Functions and their graphs, differentiation of polynomial, rational and trigonometric functions. Velocity and acceleration. Geometric applications of the derivative, minimization and maximization problems, the indefinite integral, and an introduction to differential equations. The definite integral and the Fundamental Theorem of Calculus.
10. **MATH 1220 Calculus II**. Geometric applications of the integral, logarithmic, and exponential functions, techniques of integration, conic sections, improper integrals, numerical approximation techniques, infinite series and power series expansions, differential equations (continued).