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CREATING A SEAMLESS PIPELINE INTO UNDERGRADUATE PROGRAMS IN STEM FIELDS THROUGH REGION-WIDE ARTICULATION AGREEMENTS

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Immanuel A. Edinbarough received his B.Sc. (Applied Sciences) degree from PSG College of Technology, University of Madras, India, his B.E.. (M.E.) degree from the Institution of Engineers, India, M.E. (Production Engineering) degree from PSG College of Technology, Bharathiar Univesrity, India and his Ph.D. in mechanical engineering from the Bharathiar University, India. He is currently a professor and Director of Engineering Technology at The University of Texas at Brownsville (UTB). Prior to joining the faculty at UTB he was a visiting professor at the Rochester Institute of Technology, Rochester, NY. Also, an Associate Professor of Production Engineering Technology at PSG College of Technology Bharathiar University, India, where he served as the Director of Computer Vision Laboratory and National Cadet Corps – Engineering Division Director. With over 26 years of teaching and research experience in manufacturing/mechanical engineering and engineering technology, he currently teaches in the areas of CAD/CAM/CIM, Robotics & Automation, Product and Process Design, Materials and Manufacturing processes, Machine Design, Renewable Energy and Micro Manufacturing. His current research interests include Robotics, CIM, Sustainable Manufacturing, Micro Machining and Engineering & Technology Education. He has published several papers, in these areas, in various national & international conferences and journals. He has worked in heavy and light manufacturing industries manufacturing pumps, motors, and CNC machine tools in the areas of system design, production planning and control and manufacturing. Edinbarough also served in paramilitary forces and in the Air Force. He is a Life Member of the ISTE, a senior life member of the IE (India), a member of the ASEE & SME, and a licensed Professional Engineer (P.E.) in the state of Texas.

Dr. Mikhail Bouniaev, University of Texas, Brownsville

Dr. Mikhail Bouniaev, Dean of the College of Science, Mathematics and Technology, and Professor of Mathematics at the University of Texas at Brownsville (UTB). He holds a Ph.D. in Mathematics from Moscow Institute of Electrical Engineering and a Doctor of Science in Pedagogy degree from Moscow State Pedagogical University. His research interests include functional analysis, topology, applied mathematics, nanosciences, psychology of mathematics education, using technology in teaching mathematics, training mathematics teachers and curriculum development. In each of these areas he has publications including 6 books and 60 peer reviewed papers. Though his scholarly work is related mostly to theoretical and applied mathematics as well psychology of mathematics education, he has extensive experience working with and supervising engineering and computer science programs, including successful ABET accreditations for both engineering and CS programs. Before joining UTB/TSC, he served as dean of the College of Computing, Integrated Engineering, and Technology and as Department Chair of Mathematics and Computer Science Department at Southern Utah University. He also served for ten years as dean of the College of Mathematics at Moscow State Pedagogical University. Dr. Bouniaev has received numerous professional recognitions and awards.

Mr. Bill W Elliott, The University Of Texas at Brownsville

Bill Elliott holds a BS degree from The University of Mary Hardin-Baylor (UMHB) and MPA from Texas State University. He has four decades of administrative management experience on the university campus and in health care education. Prior positions include Director of Admissions and Financial Aid at UMHB in Belton, TX; Director of Education for the Valley Baptist Health System, Harlingen, TX and currently he is the Coordinator for Special Projects with the Office of the Dean, College of Science, Mathematics and Technology at the University of Texas at Brownsville. He has experience in developing academic support programs for post-secondary students.

CREATING A SEAMLESS PIPELINE INTO UNDERGRADUATE PROGRAMS IN STEM FIELDS THROUGH REGION-WIDE ARTICULATION AGREEMENTS

Abstract

Underrepresented minority students pursue science, technology, engineering, and mathematics (STEM) related degrees at much lower rates compared to other segments of the population. To attract minority students, schools with STEM programs have resorted to myriad strategies such as cohorts, scholarships, mentoring, summer bridges, etc. Some schools have also sought innovative ways to develop a pipeline for graduates of two-year technical degree programs to matriculate into their four-year STEM programs and complete the remaining coursework leading to a BAT or BS degree. The University of Texas at Brownsville (UTB) has adopted this latter innovative approach to increasing student enrollment in STEM fields. The College of Science, Mathematics and Technology (CSMT) has recently completed and signed novel articulation agreements with three of the major community colleges in the region. These articulation agreements provide a pathway for community college students to seamlessly transfer into the UXX STEM programs. The community college programs covered in the articulation agreements represent a wide variety of two-year programs in the fields of engineering and technology. The seamless pipeline generated through these articulation agreements will greatly enhance the transfer of students from the two-year programs into four-year baccalaureate programs. The STEM programs at the college (CSMT) are already witnessing increased enrollment numbers as a result of the community college transfers. This paper will detail the articulation agreements, discuss the benefits of the agreements for both types of institutions, and analyze the challenges encountered in transferring technical courses from the community colleges. Preliminary enrollment data will be presented that suggests an early indication as to the future viability of the articulated programs.

I. Introduction

University of Texas at Brownsville (UTB) is a Hispanic-Serving Institution (91% Hispanic, 96% U.S. citizens) located in the southern part of the state along the Mexico border, in a region which has some of the lowest average household incomes in the nation. The majority of UTB students (73%) are the first generation of their family to seek a bachelor's degree. The University of Texas at Brownsville serves more than 8,000 students in the lower Rio Grande Valley metropolitan area and broader South Texas region. The UTB has been a member of The University of Texas System since 1991 and offers a wide range of undergraduate and graduate programs. For many years since its inception, the university has offered a number of STEM programs, including Engineering Technology programs in Mechanical, Manufacturing, and Electronics.

The University of Texas at Brownsville is a commuter campus; most of the students have to work full time. Even though the STEM programs at the College of Science, Mathematics and Technology (CSMT) are beginning to grow because of the various student support measures

implemented by the college, the problem of low enrollment in some of the STEM programs, including Engineering Technology (ET), still exists.

The ET program at the UTB also has had to tackle the challenge faced by many similar programs across the country in recent years: to maintain the identity, viability, and continued relevance of its ET programs. The UTB initiated a measure to phase-out the existing ET programs in favor of a new, generic Engineering Technology program. The three existing Engineering Technology programs were consolidated into a single generic Engineering Technology program with specializations in Design Graphics and Renewable Energy.

For its STEM programs, including the new ET program, to grow, the college had to seek innovative ways to recruit new and motivated students to its programs. One option that was adopted was to develop articulation agreements with the regional community colleges to create a pipeline through which graduates from two-year technical degree programs could matriculate into the STEM and ET programs at UTB and complete the remaining upper division work leading to a BAT or BS degree. This paper provides details of the articulation agreements between the technical programs at three community colleges in the region and the university's STEM-related BS degree programs and BS-ET degree program.

II. Motivation for Articulation Agreements

The main motivation for the articulation agreements was the aspiration to create a seamless pipeline for the two-year technical associate degree students to continue their studies at the university to earn their baccalaureate degree in any of the STEM fields, especially in Engineering Technology^{1,2,3,4,5}. Presenting a major obstacle was the fact that many of the credits earned in the technical fields by technical program students would not transfer to the baccalaureate degree at the university; hence these students would have to start fresh to pursue their BS degrees. The seamless transfer of technical credits made possible by an articulation agreement, however, would enable the students to continue their studies towards a bachelor's degree without unwanted duplication of hard work^{6,7,8,9}. Also most of the community college students are place-bound due to job and family responsibilities, and would be unable to relocate from the region to get their BS degrees. The CSMT faculty at UTB played an active role in establishing program-wide relationships with the regional community colleges, thus greatly facilitating the smooth articulation of the programs. The agreements became effective in the spring semester of 2012.

The agreements enable students who have successfully completed a two-year AAS technical program at a participating community college to transfer a block of 15-24 credits to the chosen BS programs in STEM or ET, based on their curriculum. They then matriculate into UTB and complete the upper division requirements for their particular degree program via face-to-face, hybrid, or distance education courses offered by the university faculty.

This agreement also supports the missions of the UTB and all the three regional community colleges, namely, South Texas College (STC), McAllen; Texas State Technical College (TSTC), Harlingen; and Laredo Community College (LCC), as follows.

UTB Mission

“The University of Texas at Brownsville draws upon the intersection of cultures and languages at the southern border and Gulf Coast of the United States to develop knowledgeable citizens and emerging leaders who are engaged in the civic life of their community. It embraces teaching excellence, active inquiry, lifelong learning, rigorous scholarship, and research in service to the common good. The University promotes the interdisciplinary search for new knowledge that advances social and physical well-being and economic development through commercialization, while honoring the creative and environmental heritage of its region¹⁰.”

UTB Philosophy

“UTB is committed to excellence. It is dedicated to stewardship, service, openness, accessibility, efficiency and citizenship. UTB is committed to students, participatory governance, liberal education, the expansion of the application of knowledge, human dignity, the convening of cultures and respect for the environment¹¹.”

STC 2013-2018 Comprehensive Mission

“South Texas College is a world-class institution advancing regional prosperity through education for a better quality of life in our community.

- *Collaboration
South Texas College continues to develop bridges between departments and divisions while advancing mutually beneficial community and educational partnerships to create a collective impact on student success¹²”*

TSTC Statement of Purpose

“TSTC's legislated purpose or mission is described in Vernon's Texas Education Code Section 135.01:

- *The Texas State Technical College System is a co-educational two-year institution of higher education offering courses of study in technical-vocational education for which there is a demand within the state of Texas.*
- *The Texas State Technical College System shall contribute to the educational and economic development of the State of Texas by offering occupationally-oriented programs with supporting academic coursework, emphasizing highly specialized advanced and emerging technical and vocational areas for certificates or associate degrees. The Texas State Technical College System is authorized to serve the State of Texas through excellence in instruction, public service, faculty and manpower research and economic development. The system's economic development efforts to improve the competitiveness of Texas business and industry include exemplary centers of excellence in technical program clusters on the system's campuses and support of educational research commercialization initiatives. Through close collaboration with business,*

industry, governmental agencies and communities, including public and private secondary and postsecondary educational institutions, the system shall facilitate and deliver an articulated and responsive technical education system.

- *In developing and offering highly specialized technical programs with related supportive coursework, primary consideration shall be placed on industrial and technological manpower needs of the state. The emphasis of each Texas State Technical College System campus shall be on advanced or emerging technical programs not commonly offered by public junior colleges¹³”*

Laredo Community College Mission Statement

“Laredo Community College is an institution committed to student success by providing comprehensive educational services that focus on the dynamic requirements and needs of its local, regional, and international community¹⁴.”

With the articulation agreements described in the next section, UTB is now able to accept the two-year technical degree graduates into the STEM-related BS programs, including the BS-ET program. This will enable the university to become one of the driving forces in the region to stimulate economic development through the supply of much-needed scientific and technical human power to the region.

III. Development of Articulation Agreements

The dean of the College of Science, Mathematics and Technology initiated the discussion of the articulation agreement concepts with the regional community colleges, and asked the associate dean of CSMT to further develop the details. Tailored articulation agreements with UTB were signed by each of the three leading regional community colleges. The details of the development, signing, and implementation of the articulation agreements are explained in the following subsections.

South Texas College Articulation

The dean of CSMT contacted his counterpart at STC to promote the potential articulation between the technical programs at STC and the STEM programs at CSMT. The concerned faculty of both institutions met at the university for a one-day workshop to match up the community college courses to be transferred to the respective programs at the university. The main purpose of the workshop was to team up the corresponding program chairs from both institutions to work on the details of articulation. The educational objectives and course outcomes were thoroughly examined and the block of courses eligible for university credit was established.

All of the STEM programs, including BS-ET, offered at CSMT were chosen for the articulation agreements (Tables 1a, 1b). Students must earn an AAS degree in the appropriate technology program to be eligible to enroll for the BS in STEM or BS-ET. The blocks of courses, and number of credit hours, eligible for transfer to the BS-ET program are provided in Tables 1a and 1b.

Texas State Technical College Articulation

University of Texas at Brownsville leaders signed an articulation agreement between TSTC and the UTB's College of Science, Mathematics and Technology. The details of the courses for which the transfer students will get credit at the university were meticulously worked out by the respective teams of program directors. The partnership began in the spring semester of 2012, and could lead to higher enrollment numbers at UTB.

This articulation, which took six months to finalize, is in-line with the UTB plan to grow the STEM, including ET, programs by creating a pipeline from community college. The agreement, which makes it easier for TSTC students to transfer college credits to UTB—and reserves them a seat at UTB—is expected to recruit between 300 and 400 transfer students. The college and the university will benefit from the transfer of additional qualified students to the STEM programs; the local economy will also benefit from this articulation¹⁵.

The blocks of courses, and number of credit hours, eligible for transfer to the BS-ET program is provided in Tables 2a, 2b, and 2c.

Laredo Community College Articulation

The Laredo Community College articulation agreement was initiated with a visit by the team of UTB faculty, headed by the associate dean of CSMT, with the group of LCC faculty headed by the dean of technology. The corresponding chairs of the program arrived at the articulation agreement that details the number of courses for which the LCC transfer student will get credit at the university.

The blocks of courses, and number of credit hours, eligible for transfer to the BS-ET program is provided in Table 3.

IV. Engineering Technology Articulation

The community college general education core courses do not pose problems and are seamlessly transferred. However, community college technical courses do not have a direct match with the similar university courses. This problem was overcome by the innovative grouping of the technical courses as content blocks equating to the blocks of courses in the four-year STEM programs. This method of block transferring of course credit is of great help to the community college students transferring into the four-year bachelor of science program in Engineering Technology.

V. Implementation Status

The articulations were completed in April of 2012, and the first cohort of students began attending the program in the fall 2012 semester. Since the signing of the articulations there has been a steady stream of students who, upon completion of an associate degree at one of the three community colleges, transferred to UTB and started a baccalaureate degree. Though head counts vary, on average approximately 10 to 15 students transfer to CSMT each semester. The Engineering Technology program's share of these transfers ranges from 50 to 60 percent.

The articulation partnerships are nurtured through the regular visit of UTB faculty to the community colleges, at least twice a semester. The community college students and faculty are given a thorough UTB campus tour once a year, in which they visit all of the STEM departments and labs. The community college students are encouraged to participate in joint projects, such as building robots, with the Engineering Technology students. Thus the main goal of the articulations, to increase the enrollment in UTB's STEM programs through the transfer of community college students, is achieved.

VI. Challenges

Among the challenges facing UTB is that of addressing a representation gap by recruiting and retaining additional minority students in STEM fields, and in particular the ET program. The UTB, as one of its strategies to overcome this challenge, has adopted articulation agreements with three regional community colleges. These agreements have provided a pipeline for graduates of two-year AAS programs in a variety of fields, including Architecture, CAD, Precision Machining, and Mechatronics, to transfer into UTB's ET program and other STEM majors. The university hopes to double the overall STEM and ET enrollment in the near future. These agreements are a "win-win" for both UTB and the regional community colleges. They are also in line with the missions of UTB and the participating community colleges, and are in line with the UTB's goal of providing state-of-the-art high technology programs to residents in the region. Historically, 1 in 5 students (20%) graduating from the community colleges continue their education and enroll in a baccalaureate program at the university; CSMT intends to attract the majority of this population to its STEM and ET programs through these articulations.

VII. Conclusion

The STEM programs at UTB historically have not attracted enough minority students, especially in the fields of Engineering Technology and Engineering. However, UTB is uniquely positioned to overcome this tendency—whether through articulation or other strategies—due to the demographics of the surrounding region. By virtue of the region's predominantly-Hispanic composition, nearly every local community college student (statistically, 9 in 10) recruited to UTB will be a minority student.

CSMT adopted this articulation strategy to increase the participation of minority students in these programs, by maximizing the amount of community college credit that students can transfer toward a baccalaureate degree. In so doing, these agreements have provided a pipeline for graduates of two-year AAS technical programs to matriculate into UTB's ET program.

The university is making all efforts to strengthen these collaborations and address the gap of higher education, in order to help this historically underserved region to develop economically and become prosperous. The articulation agreements are a success story resulting in a "win-win" scenario for the university and the community colleges. By capitalizing on an existing resource (AAS graduates) and eliminating the need for redundant coursework, the agreements represent an efficient solution. They also serve the missions and goals of the university, the participating community colleges, and the state.

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Table 1a: UTB – STC Articulation Agreement for Engineering Technology

PROGRAM ARTICULATION EXHIBIT

between

Bachelor of Science in Engineering Technology, at
The University Texas at Brownsville

and

Associate of Applied Science in Architectural Drafting,
Associate of Applied Science in Design and Technical Graphics,
Associate of Applied Science in Civil Drafting, at
South Texas College

In regards to the aforementioned academic programs, up to 16 SCH will be transferred to UTB as a block, possibly in addition to core completion, toward the BS in Engineering Technology (ET) for students earning a STC AAS degree in Architectural Drafting (AD), Design and Technical Graphics (DTG), or Civil Drafting (CD). The following courses will be credited at UTB toward the BS in ET: ENGT 1110 Introduction to ET, ENGT 1310 Design Graphics I, COSC 1301 Introduction to Computing, ENGT 1320 Design Graphics II, ENGT 1321 Basic Architectural CAD, ENGT 2350 Residential Architectural CAD.

Successful completion of articulated program(s) in the AAS AD, AAS DTG, and AAS CD assures the student and faculty of STC that the student has taken the appropriate courses, received the necessary instruction and preparation, and that similar outcome can be expected , enabling the student's progression to the next level of course sequence or requirement at UTB. Articulated programs at STC offer courses that are acceptable for transfer into lower division program of study of UTB's BS in ET degree.

<hr/>		<hr/>	
STC Program	Date	UTB Program	Date
Chair/Director		Chair/Director	
<hr/>		<hr/>	
STC Academic	Date	UTB Academic	Date
Liaison		Liaison	

Table 1b: UTB – STC Articulation Agreement for Engineering Technology

PROGRAM ARTICULATION EXHIBIT

between

Bachelor of Science in Engineering Technology, at
The University of Texas at Brownsville

and

Associate of Science in Precision Machining Technology, at
South Texas College

In regards to the aforementioned academic programs, up to 16 SCH will be transferred to UTB as a block, possibly in addition to core completion, toward the BS in Engineering Technology (ET) for students earning a STC AAS degree in Precision Machinery Technology (PMT). The following courses will be credited at UTB toward the BS in ET: ENGT 1110 Introduction to ET, ENGT 2307 Engineering Materials for ET 1, COSC 1301 Introduction to Computing, ENGT 1320 Design Graphics II, ENGT 2310 Introduction to Man Processes, ENGT 2322 Computer Integrated Manufacturing.

Successful completion of articulated program(s) in the AAS PMT assures the student and faculty of STC that the student has taken the appropriate courses, received the necessary instruction and preparation, and that similar outcome can be expected, enabling the student's progression to the next level of course sequence or requirement at UTB. Articulated programs at STC offer courses that are acceptable for transfer into lower division program of study of UTB's BS in ET degree.

<hr/> STC Program Date Chair/Director	<hr/> UTB Program Date Chair/Director
<hr/> STC Academic Date Liaison	<hr/> UTB Academic Date Liaison

Table 2a: UTB-TSTC Articulation document for Engineering Technology program

PROGRAM ARTICULATION EXHIBIT

between

Bachelor of Science in Engineering Technology, at
The University of Texas at Brownsville

and

Associate of Applied Science Degree (AAS) in Mechatronics Technology, at
Texas State Technical College – Harlingen

In regards to the aforementioned academic programs, up to 14 SCH will be transferred to UTB as a block, possibly in addition to core completion, toward the BS in Engineering Technology (ET) for students earning a TSTC AAS degree in Mechatronics Technology. The following courses will be credited at UTB toward the BS in ET: ENGT 1110 Introduction to ET, ENGT 2321 Basic Electronics, ENGT 2310 Intro to Manufacturing Processes and PHYS 1301 & 1101 or CHEM 1311 & 1101 and MATH 1314 College Algebra.

Successful completion of articulated program(s) in the AAS Mechatronics Technology assures the student and faculty of TSTC that the student has taken the appropriate courses, received the necessary instruction and preparation, and that similar outcome can be expected, enabling the student's progression to the next level of course sequence or requirement at UXX. Articulated program at TSTC offers courses that are acceptable for transfer into lower division program of study of UXX's BS in ET degree.

Director Date
Engineering Technology
Texas State Technical College

Director Date
Engineering Technology
The University of Texas at Brownsville

Provost Date
Texas State Technical College

Dean Date
College of Science, Math and Technology
The University of Texas at Brownsville

Table 2b: UTB-TSTC Articulation document for Engineering Technology program

PROGRAM ARTICULATION EXHIBIT

between

Bachelor of Science in Engineering Technology, at
The University of Texas at Brownsville

and

Associate of Applied Science Degree (AAS) in Wind Energy and Turbine Technology, at
Texas State Technical College – Harlingen

In regards to the aforementioned academic programs, up to 10 SCH will be transferred to UTB as a block, possibly in addition to core completion, toward the BS in Engineering Technology (EI) for students earning a TSTC AAS degree in Wind Energy and Turbine Technology, The following courses will be credited at UTB toward the BS in ET: ENGT 1110 Introduction to ET, ENGT 2321 Basic Electronics, ENGT 4311 Wind Energy Systems and MATH 1314 College Algebra.

Successful completion of articulated program(s) in the AAS Wind Energy and Turbine Technology assures the student and faculty of TSTC that the student has taken the appropriate courses, received the necessary instruction and preparation, and that similar outcome can be expected, enabling the student's progression to the next level of course sequence or requirement at UXX. Articulated program at TSTC offers courses that are acceptable for transfer into lower division program of study of UXX's BS in ET degree.

Director Date
Engineering Technology
Texas State Technical College

Director Date
Engineering Technology
The University of Texas at Brownsville

Provost Date
Texas State Technical College

Dean Date
College of Science, Math and Technology
The University of Texas at Brownsville

Table 2c: UTB-TSTC Articulation document for Engineering Technology program

PROGRAM ARTICULATION EXHIBIT

between

Bachelor of Science in Engineering Technology, at
The University of Texas at Brownsville

and

Associate of Applied Science Degree (AAS) in Computer Drafting and Design Technology, at
Texas State Technical College – Harlingen

In regards to the aforementioned academic programs, up to 16 SCH will be transferred to UTB as a block, possibly in addition to core completion, toward the BS in Engineering Technology (ET) for students earning a TSTC AAS degree in Computer Drafting and Design Technology. The following courses will be credited at UTB toward the BS in ET: ENGT 1110 Introduction to H, ENGTU 1310 Design Graphics I, ENGT 1320 Design Graphics II, ENGT 2350 Residential Architectural Drafting, ENGT 3350 Commercial Architectural Drafting, and MATH 1314 College Algebra.

Successful completion of articulated program(s) in the AAS Computer Drafting and Design Technology assures the student and faculty of TSTC that the student has taken the appropriate courses, received the necessary instruction and preparation, and that similar outcome can be expected, enabling the student's progression to the next level of course sequence or requirement at UXX. Articulated program at TSTC offers courses that are acceptable for transfer into lower division program of study of UXX's BS in ET degree.

_____ Director	_____ Date	_____ Director	_____ Date
Engineering Technology		Engineering Technology	
Texas State Technical College		The University of Texas at Brownsville	

_____ Provost	_____ Date	_____ Dean	_____ Date
Texas State Technical College		College of Science, Math and Technology	
		The University of Texas at Brownsville	

Table 3a: UTB-LCC Articulation document for Engineering Technology program

PROGRAM ARTICULATION EXHIBIT

between

Bachelor of Science in Engineering Technology, at
The University of Texas at Brownsville

and

Associate of Science, at
Laredo Community College

In regards to the aforementioned academic programs, courses taken at LCC will be transferred to UXX as indicated in the table below.

LCC	SCH at STC	UTB	SCH at UTB	Notes
CHEM 1411 General Chemistry I	3 Lec, 3 Lab, 4 Cr	CHEM 1311/1101 General Chemistry I and Lab	3 Lec, 3 Cr 3 Lab, 1 C	
ENGR 1304 Engineering Graphics I	2 Lec, 3 Lab, 3 Cr	ENGTU 1310 Design Graphics I	2 Lec, 3 Cr 3 Lab,	
PHYS 1401 College Physics I	3 Lec, 3 Lab, 4 Cr	PHYS 1301/1101 College Physics I and Lab	3 Lec, 3 Cr 3 Lab, 1 Cr	
MATH 1314 College Algebra	3 Lec	MATH 1314 College Algebra	3 Lec, , 3 Cr	
MATH 2412 Precalculus Math	4 Lec	MATH 2412 Pre-calculus Mathematics	3 Lec 3 Lab, 4 Cr	

LLC Program Chair/Director Date

UTB Program Chair/Director Date

LLC Academic Liaison Date

UTB Academic Liaison Date