3-30-2015

Proposal to change the number of credit hours in Precalculus (MTH 122) from 3 to 4

The College at Brockport, College Senate

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TO: Dr. John R. Halstead, College President
FROM: The College Senate: 03/23/2015
RE: I. Formal Resolution (Act of Determination)
II. Recommendation (Urging the Fitness of)
III. Other, For Your Information (Notice, Request, Report, etc.)

SUBJ: Change Credit Hours Precalculus MTH 122 (#14_14-15UC)

Signed: ___________________________ Date: 3/30/15
(P. Gibson Ralph, 2014-15 College Senate President)

Please fill out the bottom portion and follow the distribution instructions at the end of this page.

TO: P. Ralph Gibson, College Senate President
FROM: John R. Halstead, College President
RE: I. Decision and Action Taken on Formal Resolution (circle choice)
   a. Accepted - Implementation Effective Date**: Fall 2015
      **Implementation of resolution requires final approval from SUNY- State Education Department. ___YES ___NO
   b. Deferred for discussion with the Faculty Senate on ___/___/___
   c. Unacceptable for the reasons contained in the attached explanation

II, III. Response to Recommendation or Other/FYI
   a. Received and acknowledged ___/___/___

Signed: ___________________________ Date: 4/6/15
(Dr. John R. Halstead, President, The College at Brockport)

DISTRIBUTION: Upon approval, the College President will forward copies of resolutions to his staff who will, in turn, forward copies to their staff. The College Senate Office will post resolutions to the College Senate Web at http://www.brockport.edu/collegesenate/resolutions.
INSTRUCTIONS
• Use committee guidelines available at brockport.edu/collegesenate/proposal.html.
• Prepare ONE complete document in Word format: include this proposal cover page, proposal, attachments and support letters from your department chair and dean if applicable.
• Locate the Resolution # and date this proposal will replace at our “Approved Resolutions” page on our Web site.
• Email completed proposal to senate@brockport.edu. (General Education Proposals and questions go to dlamphro@brockport.edu in the Vice Provost’s Office first.)
• Make revisions on the paperwork emailed to you from the Senate office that shows the assigned routing number on top. Submit updated document to senate@brockport.edu.
• Questions? Call the Senate office at 395-2586 or the appropriate committee chairperson.

1. PROPOSAL TITLE: Please be somewhat descriptive, ie. Use a course number and/or title, indicate if for GED code, etc.
   Proposal to change the number of credit hours in Precalculus (MTH 122) from 3 to 4

2. BRIEF DESCRIPTION OF PROPOSAL:
The Mathematics Department wishes to change the number of credit hours for MTH 122 from 3 to 4 credit hours.

3. WILL ADDITIONAL RESOURCES AFFECTING BUDGET BE NEEDED? __X_ NO ____ YES EXPLAIN YES

4. DESCRIBE ANY DATA RELATED TO STUDENT LEARNING OUTCOMES ASSESSMENT USED AS PART OF THE RATIONALE FOR THE REQUESTED SENATE ACTION.
Part of the rationale for this request is that the course MTH 122 does not provide adequate preparation for postrequisite courses including MTH 281. In Fall 2013, the Department of Mathematics assessed the following Student Learning Outcome: “Students will carry out the creative and explorative processes of mathematics, including conjecture, generalization, and the construction of mathematically rigorous and logically correct proofs.” The outcome was assessed in two courses, including every section of MTH 281. In MTH 281 only 40% and 27% of the students (respectively) met or exceed expectations. (Our benchmark for success is 85%).

5. HOW WILL THIS AFFECT TRANSFER STUDENTS: If a transfer student takes Precalculus at Brockport, then the number of credit hours will increase from 3 to 4. As with traditional students, this will allow transfer students a more thorough background in mathematics. As one can see from the charts, most transfer students taking Precalculus elsewhere would already have 4 credits in Precalculus. (The rare students entering Brockport with 3-credit Precalculus would still be allowed to attempt math courses for which Precalculus is the prerequisite.)

6. ANTICIPATED EFFECTIVE DATE: Fall 2015

7. SUBMISSION & REVISION DATES: PLEASE DATE ALL REVISED DOCUMENTS TO AVOID CONFUSION.
First Submission Updated on Updated on Updated on
11-14-14

8. SUBMITTED BY: (contact person)
Name Department Phone Email
Rebecca Smith Mathematics 585-395-5183 rsmith@brockport.edu

9. COMMITTEES: (Senate office use only)
Standing Committee Forwarded To Dates Forwarded
__ Executive Committee Standing Committee 11-17-14
__ Enrollment Planning & Policies Executive Committee 02/23/15
__ Faculty & Professional Staff Policies Senate 03/02/15
__ General Education & Curriculum Policies Passed GED’s go to Vice Provost
__ Graduate Curriculum & Policies College President 04/06/15
__ Student Policies OTHER
X Undergraduate Curriculum & Policies REJECTED -WITHDRAWN

NOTES: RES # 12
1. RATIONALE FOR CHANGING THE NUMBER OF CREDIT HOURS IN MTH 122 (PRECALCULUS)

Precalculus (MTH122) is the foundation for the Calculus sequence and at the current time, even students who have just taken MTH122 the previous semester struggle with algebra and trigonometry they need to use in Calculus. Many attempts to revamp the course and cut things to the core have been made and new textbooks have been tried to maximize efficiency. Instructors who have repeatedly taught this course along with Calculus I find that it is simply unrealistic to expect students with no background in trigonometry to master this material in the current format.

Looking at peer institutions within SUNY shows why this is. To cover the minimum amount of mathematics needed in this course, most other schools either have 4 credit hours devoted to this course or in some cases, place a higher prerequisite (requiring some knowledge of trigonometry as a prerequisite). Schools requiring 4-credit Precalculus include Binghamton, Buffalo, Geneseo, and Stony Brook which are desired peer institutions when it comes to academic quality.

The Mathematics Department has every reason to believe the proposed change will allow students to be more successful in Precalculus as well as the Calculus sequence. However, the benefit of a more thorough precalculus class is not limited only to the calculus sequence. A more solid foundation can better prepare students for Discrete Mathematics (MTH281), a course required in both Mathematics and Computer Science, for which precalculus is the sole prerequisite. Elsewhere in our School, the background in algebra and trigonometry provided by a thorough precalculus course can supply students with the quantitative skills needed for success in a variety of courses throughout the School of Science and Mathematics. At the Fall 2014 School of Science and Mathematics Assessment Symposium, one common thread was a lack of mathematical preparation that is impacting students’ potential to succeed in science based course work. Whether particular deficiencies are due to weakness in calculus, algebra, or trigonometry, all signs point to a benefit of a strengthened precalculus course.

We also note that a recent and unanimously passed University Faculty Senate resolution on Undergraduate Research recognizes the value in strengthening the curriculum to better prepare students:

*Be it resolved that the University Faculty Senate supports our colleagues in their efforts to strengthen curricula that prepare students for undergraduate research.*

2. COMPARISON OF PRECALCULUS (MTH 122) WITH OTHER SUNY INSTITUTIONS

Statistics about the profile of MTH122-like courses at all SUNY schools granting a Bachelors of Science or Arts in Mathematics, are provided in the following table.

Results can be summarized as follows.

1. Eleven of the sixteen schools require 4 credit hours to bridge the gap from Algebra to Calculus.
2. Three of the four university centers and SUNY Geneseo have a 4-credit hour version of Precalculus. The last university center is not offering Precalculus this academic year. These schools traditionally take in the highest number of tier 1 students and still find a fourth credit hour of Precalculus to be in line with best practices.
### Institutions offering 4-year degrees in Mathematics

<table>
<thead>
<tr>
<th>Name of corresponding course(s)</th>
<th>Number of credits in MTH 122 (Precalculus) or equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precalculus Mathematics</td>
<td>3* (not currently offered)</td>
</tr>
<tr>
<td>Algebra and Trigonometry</td>
<td>4</td>
</tr>
<tr>
<td>Survey of Algebra and Trigonometry</td>
<td>4</td>
</tr>
<tr>
<td>Functions and Modelling II</td>
<td>3</td>
</tr>
<tr>
<td>Elementary Functions</td>
<td>3</td>
</tr>
<tr>
<td>University Precalculus &amp; Preparation for Calculus</td>
<td>3+1 (Precalculus assumes knowledge of trigonometry)</td>
</tr>
<tr>
<td>PreCalculus</td>
<td>4</td>
</tr>
<tr>
<td>PreCalculus</td>
<td>4</td>
</tr>
<tr>
<td>PreCalculus</td>
<td>4</td>
</tr>
<tr>
<td>Pre-calculus</td>
<td>3</td>
</tr>
<tr>
<td>Precalculus</td>
<td>3</td>
</tr>
<tr>
<td>Precalculus &amp; Trigonometry (must take both)</td>
<td>3+1</td>
</tr>
<tr>
<td>Pre-Calculus Mathematics</td>
<td>4</td>
</tr>
<tr>
<td>Precalculus</td>
<td>4</td>
</tr>
<tr>
<td>Precalculus</td>
<td>4</td>
</tr>
<tr>
<td>Introduction to Calculus &amp; Functions (must take both)</td>
<td>3+1</td>
</tr>
</tbody>
</table>

### 3. COMPARISON OF PRECALCULUS (MTH 122) WITH LOCAL COMMUNITY COLLEGES

Statistics about the profile of MTH 122-like courses in the local community colleges are provided in the following table.

Results can be summarized as follows.

1. All five local community colleges have four [4] contact hours for Precalculus.
2. All but one of the local community colleges give students four [4] credits for completing Precalculus.

<table>
<thead>
<tr>
<th>Local Community Colleges</th>
<th>Name of corresponding course(s)</th>
<th>Number of credits in MTH 122 (Precalculus) or equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erie CC</td>
<td>Precalculus Mathematics</td>
<td>4</td>
</tr>
<tr>
<td>Finger Lakes CC</td>
<td>Precalculus</td>
<td>3 credits, 4 contact hours</td>
</tr>
<tr>
<td>Genesee CC</td>
<td>Precalculus</td>
<td>4</td>
</tr>
<tr>
<td>Monroe CC</td>
<td>Precalculus Mathematics with Analytic Geometry</td>
<td>4</td>
</tr>
<tr>
<td>Niagara CC</td>
<td>Precalculus Mathematics</td>
<td>4</td>
</tr>
</tbody>
</table>

### 4. A LIST OF THE CURRENT PRECALCULUS OBJECTIVES

Included below is a list of the current precalculus objectives. As indicated earlier, the department just wishes to have an adequate amount of time to cover these thoroughly. It should be noted that these objectives line up with Monroe Community College’s objectives and that their course is a four-credit course.
Precalculus Objectives

Most of the course is without the use of calculators. Calculator use for exponential and trigonometric functions is in (bold).

Students should already be familiar with graphing lines and circles, Vertical Line Test for Functions, function evaluation, factoring, and other basic algebra skills.

A Basic Function and Graphing Skills
A1 Given a formula for a function, evaluate the function at a specified value of the independent variable.
A2 Graph the basic parent functions:

$$f(x) = x, \quad f(x) = x^2, \quad f(x) = x^3, \quad f(x) = \sqrt{x}, \quad f(x) = |x|, \quad f(x) = \frac{1}{x}$$

A3 Graph transformations of the basic parent functions including vertical shift, vertical stretch, horizontal shift, horizontal stretch, reflection over y-axis, and reflection over x-axis.
A4. Given the function formula, list the transformations of the parent function and determine the domain and range of the transformed function.
A5 Given a function represented by a formula, determine the zeros, x-intercepts, and y-intercept, domain.
A6 Determine the domain, range, intercepts, symmetry, equations of asymptotes (vertical, horizontal, slant) of a function given its graph.
A7 Determine algebraically the symmetry of a function with respect to x-axis, y-axis, and origin.
A8 Graph piecewise functions.
A9 Evaluate piecewise functions graphically and algebraically.
A10 State the piecewise definition for absolute value function.
A11 Determine the sum, difference, product, quotient, and composition of two functions, and the domain of each.
A12 Determine graphically whether a function is 1-1.
A13 Determine the inverse of a function algebraically and give the domain and range of each.
A14 Sketch the inverse of a function given its graph, restricting the domain and codomain when necessary, by reflecting over the line $y = x$.

B Polynomial Functions
B1 Given a quadratic function in $y = ax^2 + bx + c$ find the vertex, axis of symmetry, intercepts, and graph using this information.
B2 Use the discriminant to characterize the roots of a quadratic function.
B3 Given a quadratic function in $y = a(x - h)^2 + k$ form, graph using transformations and identify the vertex, axis of symmetry, and intercepts.
B4 Determine end behavior of a polynomial function using the Leading Coefficient test.
B5 Find zeros of a polynomial using factoring, complete the square, and/or quadratic formula.
B6 Find possible rational zeros of a polynomial function using Rational Zeros Theorem and then use synthetic division to determine actual rational zeros.
B7 Find all zeros (real and/or complex) of a polynomial function with multiplicity.
B8 Use properties of multiplicity to determine graphing behavior (cross, turn, bounce).
B9 Fully factor polynomial functions as a product of linear factors.
B10 Review long division of polynomials.
B11 Use synthetic division when dividing by a linear polynomial.
B12 Given a polynomial $p(x)$ use the Remainder Theorem to determine $p(c)$.
B13 Given a polynomial $p(x)$ use the Remainder Theorem to determine if $x - c$ is a factor of $p(x)$ and/or if $c$ is a zero of $p(x)$.
B14 Given a polynomial with real coefficients and a complex zero $a + bi$, use conjugate complex zeros to find $a - bi$ is also a zero.
B.15 Graph polynomial functions using end behavior, y-intercept, zeros (with multiplicity), symmetry, and extra points
B.16 Use the Fundamental Theorem of Algebra to find a polynomial function of lowest degree having integer coefficients that has given zeros
B.17 Solve polynomial equations and express solution in set builder notation, interval notation, and on the real number line
B.18 Solve applied word problems using polynomial functions
B.19 Use the Intermediate Value Theorem to determine integers that surround a zero of a polynomial and/or show that an open interval contains a zero

C Rational Functions
C1 Determine the domain, intercepts, symmetry, asymptotes (vertical, horizontal, slant), and holes both algebraically and graphically for a given rational function
C2 Graph rational functions

D Exponential and Logarithmic Functions
D1 Review exponent rules
D2 Review use of logarithm properties to rewrite expressions using logarithms including expanding/condensing
D3 Evaluate common and natural logarithms
D4 Solve exponential and logarithmic equations in one variable
D5 Solve applied word problems involving exponential functions, including examples where given information must be used to solve for the value of growth/decay rate k (using calculators to get a numerical approximation at the end)
D6 Graph an exponential function of the form $y = b^x$ (in particular $y = e^x$) and determine the domain, range, y-intercept, and horizontal asymptote
D7 Graph a logarithmic function of the form $y = \log_b x$ (in particular $y = \ln x$) and determine the domain, range, x-intercept, and vertical asymptote
D8 Use translations to sketch vertical and/or horizontal shifts and reflections of exponential and/or logarithmic functions, and determine the domain, range and asymptotes of the translated function
D9 Recognize the inverse relationship between exponential and logarithmic functions graphically
D10 Algebraically determine the inverse of exponential and logarithmic functions

E Trigonometric Functions
E1 Convert angles measures between radians and degrees
E2 Use the arc length formula to find arc length, central angle, or radius given the other information
E3 Find coterminous angles, supplementary angles, and complementary angles given an angle (both radians and degrees)
E4 Using points on a unit circle, find the exact values of the 6 trigonometric ratios of the special angles $0, \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{2}, \frac{3\pi}{2}$ radians (and in degrees)
E5 Find reference angles and use symmetries of a unit circle to determine exact values of the trig functions for any integer multiples of the special angles mentioned above
E6 Find all angles satisfying a given trigonometric value and constraint
E7 Sketch the graphs of all six trigonometric functions
E8 State the domain, range, amplitude, period for all six trigonometric functions
E9 Sketch the graph and find domain, range, amplitude, period, phase shift, vertical shift of a transformed function of the form $y = Af(Bx + C) + D$
E10 Given the graph of a trigonometric function, identify the equation of the function
E11 State and use the formulas for 3 Pythagorean identities, Sum and difference of two angles, double angle, and half angles
E12 Solve trigonometric equations for exact values of the variable
E13 Evaluate inverse trigonometric function expressions
E14 Graph inverse trigonometric functions, noting domain and range
E.15 Use right triangle trigonometry to solve right triangles and applications
E.16 State and use the Law of Sines and Law of Cosines to solve oblique triangles and applications (with calculators)
F. Conic Sections
F.1 Given the equation of a conic section classify it as a circle, parabola, ellipse, or hyperbola
F.2 Use complete the square to rewrite the form $Ax^2 + By^2 + Cx + Dy + E = 0$ in standard form
F.3 Given the equation of a parabola, determine vertex, focus, directrix (graph using any technique)
F.4 Given the equation of a circle, determine the center and radius and graph
F.5 Given the equation of an ellipse, determine the center, vertices, co-vertices, foci, major axis with length, minor axis with length (graph the ellipse using vertices and center)
F.6 Given the equation of a hyperbola, determine the center, the vertices, the foci, the equations of asymptotes (graph using center, vertices, and asymptotes)
F.7 Given features, determine the equation of the conic section

4. LETTERS OF SUPPORT FOR THE CHANGE

While no department explicitly requires Precalculus for its majors, Precalculus is an important prerequisite for several Science and Mathematics courses. While it is expected that students would complete Precalculus in high school, there is a large pool of students that lack this preparation before they come to Brockport. As such, we have letters of support from the Chair of Mathematics, the Chair of Physics, the Chair of Computer Science, the Chair of Chemistry, and the Dean of the School of Science and Mathematics, which are included below.
College Senate
The College at Brockport

I am writing to you to indicate my strong support for the Department of Mathematics' request to increase the number of credit hours for our PreCalculus course (MTH 122) from three to four hours.

Many science, mathematical and business faculty consider the first calculus course to be one of the most important courses that their majors will take in providing a solid foundation for their studies in their respective fields. Underlying this premise is that such students have had a thorough high school background in the course material contained in PreCalculus, MTH 122. If such students have not had such a background, as is the case with many college students nowadays, then the PreCalculus course becomes the most crucial course.

You cannot have any success with calculus without having a solid understanding of all of the material in a standard PreCalculus course. Mathematics is a very sequential field. Students with a grade lower than C in the PreCalculus course will almost always fail the subsequent calculus courses.

With the present 3-credit course several important topics just can't be covered and those topics that are covered are covered at break-neck speed. Mathematics takes time. The current situation is bad for both for students and faculty. Two experienced instructors (including Mike Dentino, Director of the Student Learning Center) have told me to never assign them to this course again because of the frustration of not having enough time to cover the material in the 3-credit format. Several of our adjuncts, who usually teach this course, tell me that they teach this course as a 4-credit course at neighboring institutions. With our 3-credit course they are forced to make cuts in the material covered and to fly through important topics. Not a good situation.

Last week the School of Science and Mathematics had our Annual Assessment Symposium. Several of the programs concluded that many of their Student Learning Outcomes were hindered by weak mathematical skills, especially in the pre-Calculus area. Their solutions for "closing the loop" were to improve the mathematical skills of their students with extra add-ons or sessions.
Increasing the time students spend in PreCalculus from 3 to 4 hours would be a better solution to this problem - a 33% increase in class time should make a huge improvement throughout the school curriculum.

The department recommendation comes from our Undergraduate Committee, chaired by Professor Rebecca Smith, which has done an excellent job of researching the PreCalculus offerings at our sister institutions and community colleges and justifying our request. A large majority of those institutions offer their PreCalculus as a 4-credit course and the time has come for Brockport to do the same.

Sincerely yours,

Dr. Sanford Miller
SUNY Distinguished Professor of Mathematics
Acting Chair, Department of Mathematics
Sandy,

The Department of Physics supports the addition of an hour of instruction and associated credit to MTH 122 Precalculus. While this change does not have a direct effect on us, it should result in students being better prepared for PHS 205 for which it is a pre-requisite.

Best regards,

Stanley F. Radford, Ph. D.
Professor and Chairman
Department of Physics
The College at Brockport
Brockport, NY 14420
585-395-5576
Dr. Kadathur B. Lakshmanan  
Professor and Chair  
KLakshma@brockport.edu

TO WHOM IT MAY CONCERN

Re: MTH 122 and MTH 281

The Department of Computer Science offers two majors – a major in Computer Information Systems and a major in Computer Science. In Computer Science, there are two tracks – Advanced Computing and Software Development.

The Information Systems major and the Advanced Computing Track of the Computer Science major are accredited by the Computing Accreditation Commission (CAC) of ABET. Both are rigorous programs requiring several mathematics courses beyond pre-calculus level, in particular including MTH 281 Discrete Mathematics I.

It is known in the department through anecdotal evidence and assessment of program outcomes that many of our students have weak mathematical preparation that is hindering their ability to be successful in our courses. MTH 281 Discrete Mathematics I has been a particularly difficult course for many of our students as it relates to mathematics and proof techniques that they are not exposed to in high school years. We believe any effort to strengthen instruction and student learning in mathematics courses is welcome and will ultimately lead to student success in computing.

The Department of Computer Science fully and strongly supports the proposal from the Department of Mathematics to add one more credit to MTH 281 Discrete Mathematics I. We expect to work very closely with the Department of Mathematics to ensure that the extra credit of course work includes some material essential for our programs.

For the same reasons stated above, The Department of Computer Science fully and strongly supports the proposal from the Department of Mathematics to add one more credit to MTH 122 Pre-calculus, which is preparatory for many college-level mathematics courses, including MTH 201 Calculus I and MTH 281 Discrete Mathematics I. Strengthening MTH 122 by itself is not sufficient as our program relies on many transfer students who may not take MTH 122 at Brockport.

Kad Lakshmanan

The College at Brockport, State University of New York, 350 New Campus Drive. Brockport, New York 14420-2933  
(585) 395-2146. FAX (585) 395-2304. www.brockport.edu/cs
To: The Senate Undergraduate Curriculum Committee  
From: Stephen Godleski, Chair of the Department of Chemistry and Biochemistry

I support the proposal from the Department of Mathematics to increase the credit hours awarded for MTH 122 (Pre-calculus) from 3 to 4 credits. My understanding from the Math Department is that the additional meeting time this would provide will allow them to cover the necessary content for this class which is something they currently struggle to do. It is our experience in Chemistry that students who struggle in Gen CHM often do so because of having a poor background in math. Anything that can be done to improve the math skills of our students would be of great benefit.

On Nov 14, 2014, at 12:08 PM, Rao, T <trao@brockport.edu> wrote:

Hello Rebecca,

The Deans office fully supports the two College Senate proposals from the Department of Mathematics, to increase the number of credits for MTH 122 (from three to four) and also for MTH 281 (from three to four).

All the best,
T.M. Rao