



April 25, 2018

James D. Fielder, PhD.
Secretary of Higher Education
Maryland Higher Education Commission
6 N. Liberty Street
Baltimore, MD 21201

Timothy J. L. Chandler, Ph.D.
Provost and Executive Vice-
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Dear Secretary Fielder:

Please find enclosed a proposal to offer a new program at Towson, the **Master of Science in Actuarial Science and Predictive Analytics**. The Jess & Mildred Fisher College of Science and Mathematics proposes this new degree in response to demand in the fast growing actuarial science job market and to fill a gap in the state system for graduate education in the actuarial field.

Towson University provides the only Center of Actuarial Excellence (CAE) recognized by the Society of Actuaries in the state with its undergraduate concentration in Actuarial Science and Risk Management. The Society of Actuaries has recognized only 17 such CAEs in the nation. The proposed program builds on the strength of that program.

We respectfully request the Commission's consideration of this proposal.

Sincerely,

A handwritten signature in black ink, appearing to read "TJL Chandler".

Timothy J. L. Chandler, Ph.D.
Provost and Executive Vice President
for Academic Affairs

TJLC/wf

cc: Dr. David Vanko, Dean, Fisher College of Science and Mathematics, Towson University
Dr. Vonnie Shields, Associate Dean, Fisher College of Science and Mathematics,
Towson University
Dr. Janet DeLany, Dean of Graduate Studies, Towson University
Dr. Antoinette Coleman, Associate Vice Chancellor for Academic Affairs, USM

MARYLAND HIGHER EDUCATION COMMISSION
ACADEMIC PROGRAM PROPOSAL

- NEW INSTRUCTIONAL PROGRAM
 SUBSTANTIAL EXPANSION/MAJOR MODIFICATION
 COOPERATIVE DEGREE PROGRAM
 WITHIN EXISTING RESOURCES or REQUIRING NEW RESOURCES



Fall 2018

Projected Implementation
Date

M.S.

Actuarial Science and Predictive Analytics

Award to be
Offered

Title of Proposed Program

Main Campus

Location

Face-to-Face

Method of Delivery

Suggested HEGIS Code

52.1304 Actuarial Science

Suggested CIP Code

Mathematics

Department of Proposed
Program

Dr. Michael O'Leary

Name of Department Head

Gary Levy

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410-704-4382

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Signature/Date

President/Chief Executive Approved

Date

4/4/2018

Date Endorsed/Approved by Governing Board

Executive Summary

The Mathematics Department at Towson University proposes a new Master of Science in Actuarial Science and Predictive Analytics degree program. Actuarial Science is a field that uses mathematical, statistical and computer skills to identify, quantify, measure, and manage risk in insurance, finance, and other industries. Actuaries are business executives who are professionally trained in the mathematical sciences and who specialize in the evaluation of financial risk. They help the business and individuals make decisions and plan for the future.

Recently the actuarial field has experienced significant growth opportunities and changes as it keeps up with new and emerging fields of application, particularly in the risk assessment and predictive analytics areas. These new areas have been widely recognized and are being incorporated into new educational curriculum across the field. The Society of Actuaries (SOA) updated curriculum emphasizes “the use of predictive analytics has spread to most areas of actuarial practice”¹ and actuaries need to have data analytics skills beyond regression and time series.

The changes in the actuarial field represent an opportunity for Towson University to continue to build on its nationally lauded actuarial undergraduate concentration with the proposed new program. The proposed program will specialize in offering advanced level Actuarial Science curriculum specialties of forecasting, predictive modeling, and risk analysis/management. It will also incorporate emerging tools in technology, statistical and data analysis, and quantitative analysis to prepare students to be well positioned in the actuarial science field.

Market considerations show strong support and need for the proposed program

1. The profession of actuary is consistently ranked among the top professions using criteria such as income, security, employment prospects, and work environment².
2. The U.S. Department of Labor predicted (Department of Labor Occupational Handbook, 2014), “Employment of actuaries is projected to grow 18 percent from 2014 to 2024, much faster than the average for all occupations.”³
3. There is strong support and desire from local companies for the proposed program. We have recently visited the local companies, such as, Transamerica, Aetna, and Travelers etc. They all support the proposed program.
4. There is strong interest and demand from students at Towson for the proposed program. The proposed graduate program would also increase the attractiveness of the undergraduate Actuarial Science and Risk Management (ASRM) concentration to prospective students.

¹Society of Actuaries, ASA and CERA Curriculum Changes Fact Sheet:
<https://www.soa.org/Education/General-Info/2016-asa-cera-curriculum-changes.aspx>

² Be an Actuary, <http://www.beanactuary.org/what/top/?fa=a-top-ranked-job>

³ Bureau of Labor Statistics, <https://www.bls.gov/ooh/math/actuaries.htm>

Builds upon strong and nationally recognized undergraduate program

1. The undergraduate Actuarial Science and Risk Management concentration of the Mathematics degree at Towson University is one of the best actuarial science programs in the country – it is the only program in Maryland recognized as a Center of Actuarial Excellence (CAE) by the SOA and is one of only 17 CAEs in the entire country.
2. The ASRM faculty members at Towson are experts, committed and well trained in the fields. The foundations for the proposed program are very strong.

Uniquely and strongly positioned

1. There are no similar graduate programs in Maryland. The addition of this program would serve the needs of students in Maryland and fill the current actuarial science graduate education gap in the state.
2. Graduate programs in Actuarial Science have become more important in recent years and have been adopted by many universities. Eleven of the 17 recognized CAE all offer graduate programs. The proposed ASPA program is expected to provide a strong competitive advantage relative to other actuarial science programs due to implementing the advanced emerging techniques into the curriculum.

Minimal Financial Risk and Investment

1. Program costs are minimal, with no increases in full-time faculty until the third year of the program.
2. Increased revenues are expected from the ASRM undergraduate students continuing their Master's degree after graduation. Recruitment of new students looking for new opportunities will also help to increase revenue.
3. The proposed program will be an interdisciplinary and collaborative effort with the current Master of Science in Applied and Industrial Mathematics program of the Mathematics department. There will be synergistic opportunities in designing and offering courses.

Program Delivery Details

1. The proposed program will require at least 10 courses (a minimum of 30 units) and pass at least two Society of Actuaries professional exams.
2. Graduate only courses will be available in a weekend and evening format that accommodates both part-time and full-time students.

Aligns with Maryland State and Towson University's Missions and Goals

1. The proposed program is consistent with Towson University's mission to provide select, high quality programs in professional fields where there is evidence of both need and of corresponding institutional strength.
2. The proposed program aligns goals set forth by the Maryland State Plan for Postsecondary, Quality and Effectiveness, Economic Growth and Vitality, and Affordability and Completion:

A. Centrality to institutional mission statement and planning priorities

Towson University's Fisher College of Science and Mathematics proposes a new Master of Science in Actuarial Science and Predictive Analytics. The proposed master's program of 30 credits will prepare students to succeed in an occupational marketplace that has increasingly adopted risk management practices and data analytics. The program will combine theory, practice, and predictive modeling to provide students with critical and analytical tools. The program will be the first of its kind in Maryland, will build upon the strength of a popular undergraduate program at TU, and will prepare students for a field projecting 25% job growth in Maryland from 2014-2024.⁴

Relationship to the Towson University Mission, Vision, and Strategic Plan

The proposed Master of Science in Actuarial Science and Predictive Analytics (ASPA) program reflects Towson University's mission, vision, and strategic plan. The new program is designed to

1. Build an interdisciplinary foundation in actuarial science with emerging technology, predictive modeling, and curricular content that encourages "thinking critically and meaningfully"
2. Provide select, high quality programs in professional fields where there is evidence both of need and of corresponding institutional strength. The Master of Science degree in Actuarial Science and Predictive Analytics will produce graduates who can meet the challenges of the actuarial profession today, prepare for the opportunities of tomorrow, and ultimately "enrich the culture, society, economy, and environment of Maryland, the region, and beyond"
3. Provide the most current and advanced skill sets and knowledge in the Actuarial Science professional career that align with national trends and span the areas of STEM, business, and finance education
4. Engage students in Maryland, serving communities' needs and providing our students with varied internship and service learning opportunities through industry relationships, networking opportunities, a capstone and professional practices course, and a recommended internship
5. Empower students to achieve their career goals and "enrich the culture, society, economy, and environment of Maryland, the region, and beyond" through a careful curricular plan that targets a student's academic growth while seeking required experiences needed to support career outcomes
6. Create a more diverse and inclusive campus by attracting minority students as well as international students. The program reflects the mission statement of TU, whose institutional objectives include a commitment to educating "local and global citizenship and leadership."

⁴ Department of Labor and Statistics, Occupation Profile: Actuaries. Collected from www.careeronestop.org/Toolkit/Careers/Occupations/occupation-profile.aspx?keyword=Actuaries&onetcode=15201100&location=Maryland on Aug 30, 2017.

Relationship to the Jess & Mildred Fisher College of Science & Mathematics (FCSM) Mission and Vision

The proposed program is designed to:

1. Reflect the mission of the FCSM at TU; the program will “serve the metropolitan community as well as to meet regional, national and international needs.”
2. Provide “the best and most effective learning” in alignment with the FCSM mission by offering a truly interdisciplinary graduate course of study and requiring students to pass two Society of Actuaries international professional exams.
3. Enhance the quality of the education to ensure students are “fully qualified to work in any setting and also to lead others with their passion for discovery.” For example, students with two SOA exams and internship experience are able to find a very good job locally and globally to start the actuarial career. Many CEOs, CFOs, and Presidents of companies are actuaries.

B. Critical and compelling regional or Statewide need as identified in the State Plan

The proposed new program provides the quality and effectiveness that will fulfill the current education gap in the State and will meet postsecondary education goals in Maryland.

The need for Quality and Effectiveness:

The proposed MS in Actuarial Science and Predictive Analytics program will align the goal 1 of the Maryland State Plan for Postsecondary Education, Quality and Effectiveness.

The undergraduate concentration in Actuarial Science and Risk Management at Towson University has continued to focus on quality and effectiveness of its program, and these continued efforts have supported the program’s recognition of excellence in the actuarial community. The current program at Towson is recognized as 1 of only 31 Centers of Actuarial Excellence (CAE) internationally, and 1 of only 17 CAE nationally. The proposed program builds upon the excellence of the undergraduate program with emphasis on continued excellence from faculty and staff; introduction of modern skillsets, knowledge, and technology; and enhanced opportunities of hands-on real world experience for the students.

The need for Economic Growth and Vitality:

The proposed ASPA program will align the goal 5 of the Maryland State Plan for Postsecondary Education, Economic Growth and Vitality. The Plan notes,

Postsecondary education is an engine of economic growth and vitality. Individuals who obtain degrees and other credentials receive higher earnings, are employed at a higher rate, and generate improved tax receipts for the State, counties, and municipalities than those without advanced skills and training.⁵

1. Further actuarial education of more students satisfies strong market demand for actuarially trained professionals and supports economic growth and vitality. Multiple sources strongly point to the need for more actuarial professionals:
 - Jobs Rated Almanac - Although an unheralded profession, “actuary” continues to be ranked among the top professions by *Jobs Rated Almanac*.⁶ Using criteria such as income, security, employment prospects, and work environment, the profession consistently places at or near the top of over 200 career choices. The Jobs Rated Almanac voted the actuarial profession as the No. 11 profession in the United States in 2017. CareerCast.com ranks predictive analytics trained professionals, such as data scientists and statisticians in the top five careers.⁷
 - Department of Labor Projections – The proposed program is designed to provide students with the skills necessary to conduct financial analysis and manage financial risks. U.S. Department of Labor projections indicate a growing need for actuaries in coming years (Department of Labor Occupational Handbook, 2016). Employment growth is expected in finance and investment, banking, software development, health services and management, and actuarial consulting. The rise in terrorism is expected to increase the need for experts in risk assessment and management. Employment of actuaries is projected to grow 18 percent nationwide from 2014 to 2024, much faster than the average for all occupations. The median salary is over \$100,000 per year in the U.S.⁸, and the mean annual wage is over \$120,000 in Washington-Arlington-Alexandria, DC-VA-MD-WV Metropolitan Division⁹ which is much higher than almost all careers in Maryland.¹⁰
 - Employment of statisticians (Predictive Analytics) is projected to grow 34 percent nationwide from 2014 to 2024, much faster than the average for all occupations.¹¹ Growth is expected to result from more widespread use of

⁵ Maryland Higher Education Commission. *Maryland Ready 2013-2017: Maryland State Plan for Postsecondary Education*. p.54.

⁶ Be an Actuary <http://www.beanactuary.org/what/top/?fa=articles>

⁷ CareerCast.com.. *Jobs Rated Report 2017: Ranking 200 Jobs*. Collected from <http://www.careercast.com/jobs-rated/2017-jobs-rated-report> on Aug 30, 2017.

⁸ Occupational Outlook Handbook :<http://www.bls.gov/ooh/math/actuaries.htm>
https://www.careerinfonet.org/occ_rep.asp?next=occ_rep&Level=&optstatus=001000000&jobfam=15&id=1&nodeid=2&soccode=152011&menuMode=&stfips=24&x=65&y=16

⁹ Bureau of Labor Statistics. Collected from <https://www.bls.gov/oes/current/oes152011.htm> on Aug 30, 2017.

¹⁰ Payscale.com. Collected from <http://www.payscale.com/research/US/State=Maryland/Salary> on Aug 30, 2017.

¹¹ Department of Labor. Collected from <https://www.careeronestop.org/toolkit/careers/occupations/Occupation-profile.aspx?keyword=Statisticians&onetcode=15204100&ES=Y&EST=statistician> on Aug 30, 2017.

statistical analysis to make informed business and healthcare decisions. Actuaries with backgrounds in predictive analytics gain a competitive career advantage.

2. The actuarial profession has grown in demand in fields not traditionally thought of as actuarial in nature. This growth is expected to continue:
 - Increasingly, actuaries with a background of predictive analytics serve as consultants to companies that do not have actuaries on staff to develop pension and retirement planning programs. Management consulting, especially human resource consulting in the healthcare and retirement planning field, is expected to grow faster than the average. In addition, to meet the growing need of the aging population to manage retirement planning, actuaries will increasingly find roles as financial planning advisors.
 - Risks associated with terrorism have dramatically increased in recent years, and actuaries will increasingly find opportunities to evaluate and manage these risks. Additionally, actuaries will continue to be needed to evaluate risks associated with other catastrophes, such as earthquakes, tornadoes, hurricanes, floods, and other natural disasters. Environmental and operational risk management are growing areas in the fields of property and casualty insurance. Actuaries evaluate risks such as the likely environmental impacts of water environmental management, or the costs and benefits of implementing pollution control equipment in a factory. Finally, they rely on actuaries to evaluate the risks of building versus buying new facilities or capital equipment.
 - Fraudulent financial reporting issues (e.g., the 2002 collapse of Enron) have increased the need by many organizations for enterprise risk management to manage internal audit, investments, strategic planning, pricing of financial products, compliance, and capital planning. Actuaries will increasingly find opportunities in this new organizational function, as the Chief Risk Officer, or as consultants to the Chief Risk Officer.¹²

The need for access and affordability

The proposed MS in Actuarial Science and Predictive Analytics program also will respond directly to goal 2 of the Maryland State Plan for Postsecondary Education, Access, Affordability, and Completion. The Plan notes, “in ensuring that all Marylanders who can benefit from and are willing to engage in postsecondary education have the opportunity to do so.” (p28)

1. Graduate Education Need in the State

- A unique and singular program in Maryland: There are no Master’s program in Actuarial Science in Maryland currently. The addition of this program would serve the needs of students in Maryland and fill the gap in the current actuarial science graduate education field. Student inquiries in recent years have pointed to strong interest and desire. An in-house survey also shows current Actuarial Science

¹² Be an Actuary. <http://www.beanactuary.org/why/?fa=non-traditional-trajectories>.

and Risk Management students are interested in continuing to a Master's program.

- Furthermore, Graduate programs in Actuarial Science have become more important in recent years and have been adopted by many universities – 11 of the 17 recognized CAEs in the U.S. offer graduate programs. Universities in the surrounding region such as Columbia University in New York, George Mason University in Virginia, and Temple University in Pennsylvania offer graduate programs as well.

2. One of the only affordable graduate programs in Actuarial Science for Maryland students

- When reviewing graduate level programs in the surrounding areas, it is clear that the proposed program will be one of the only affordable graduate programs for Maryland students in the wider region. In fact surrounding programs mentioned above (Columbia University in New York, George Mason University in Virginia, and Temple University in Pennsylvania) require almost 2 or 3 times the tuition for all students or out of state students (see Section D for details).
- The proposed program will offer additional opportunity to students across Maryland State who may want to pursue advanced degree in actuarial science and predictive analytics. This gives an opportunity, for example, for a student with an undergraduate degree in actuarial science or related fields from Morgan State University or Loyola University to advance their actuarial education in state where they may previously have had to go to the Universities in other States.

C. Quantifiable and reliable evidence and documentation of market supply and demand in the region and State

The Actuaries occupation consistently rates as one of the best jobs in America according to work environment, employment outlook, job security, growth opportunity, salary, and more. The Economic Development and Employer Planning System (EDEPS), for example, predicts actuarial job opening growth to significantly outpace other fields in the next 10 years. The optimistic career outlook for actuaries is similarly reflected in Maryland and surrounding regions. The Maryland Department of Labor, Licensing and Regulation (DLLR) projects a 25.1% increase in the actuarial occupation from 2014 - 2024 (Appendix 1).

The EDEPS Occupational Supply Demand Report projects, on average, 1170 job openings for actuaries nationally, and over 100 job openings for actuaries in Maryland, D.C., and Pennsylvania.

Current and Projected Supply of Graduates with Bachelor's Degrees:

Although the actuarial employment market is expanding, there remains only one other actuarial program (Morgan State University Undergraduate) in Maryland other than Towson University’s concentration of the Mathematics bachelor’s program and the Loyola University Maryland concentration of the Statistics bachelor’s program. The proposed program would be the only Master’s program in Actuarial Science in the state and would serve a vital role in furthering the educational needs of students.

Table 2. Enrollment Trends

MARYLAND HIGHER EDUCATION COMMISSION TRENDS IN ENROLLMENT BY PROGRAM: BACHELOR’S					
ACTUARIAL SCIENCE	2012	2013	2014	2015	2016
0504-01 Morgan State University	21	24	20	22	27
1702-01 Loyola University Maryland (Statistics)*	9	13	20	26	27
1701-00 Towson University (Math)*	233	251	255	244	225

Source: MHEC Trends in Enrollment Data by Program

*The MHEC enrollment data display the program-level enrollments; the Commission does not disaggregate the data by concentration. Actuarial Science and Risk Management (ASRM) is the largest one of the four concentrations in the Mathematics Department of Towson University. The other three concentrations are Mathematics education, Pure Mathematics, and Applied Mathematics. Loyola University Maryland’s Statistics program includes two concentrations: Actuarial Science and Statistical Science.

Degree Data at the Undergraduate level:

Table 3. Degree Trends

MARYLAND HIGHER EDUCATION COMMISSION TRENDS IN DEGREES BY PROGRAM: BACHELOR’S					
	2012	2013	2014	2015	2016
0504-01 Morgan State University (Actuarial Science)	1	2	7	2	6
1702-01 Loyola University Maryland (Statistics)	3	3	5	3	5
1701-00 Towson University (Math)*	47	52	47	44	44

Source: MHEC Trends in Degrees and Certificates by Program

Table 4. Towson University Disaggregated Degrees with Actuarial Science Concentration

TOWSON UNIVERSITY TRENDS IN DEGREES: ACTUARIAL SCIENCE CONCENTRATION					
ACTUARIAL SCIENCE	2012	2013	2014	2015	2016
1701-00 Towson University (Math)*	47	52	47	44	44
ACTUARIAL SCIENCE AND RISK MANAGEMENT CONCENTRATION	19	27	21	20	17

Source: Towson University

D. Reasonableness of program duplication

The proposed program will be the only Master of Science in Actuarial Science and Predictive Analytics program in Maryland. This program will not result in any program duplication in Maryland.

There are some Master of Science in Actuarial Science programs in the larger surrounding area, but the proposed program is unique among these programs and will not be a duplication of any of these existing programs. The proposed TU program differs from these programs in the region in the following ways:

- The proposed program builds upon and complements the existing undergraduate actuarial concentration at TU that is nationally recognized as a Center of Actuarial Excellence (CAE).
- The proposed program will train students beyond just Actuarial Science. It uses Actuarial Science as a foundation to train candidates in predictive analytics and risk management skills which can serve as a differentiator in the actuarial field and also have broad appeal and applicability beyond the actuarial field.
- The proposed program is considerably more affordable than the other programs.

The following table compares the proposed program to all Master programs in the surrounding area.

Table 5. Master’s Programs, Mid-Atlantic Region

PROGRAM	STATE	OTHER ACTUARIAL SCIENCE DEGREES OFFERED	TUITION / CREDIT	ANNUAL FEES	Center of Actuarial Excellence Status (YES/NO)
Columbia University - Actuarial Science M.S. ¹³	NY	None	\$2018	\$948	*No
George Mason University – Actuarial Science graduate certificate ¹⁴	VA	None	\$1516	\$300	*No
Temple University – Actuarial Science M.S. ¹⁵	PA	Bachelor’s and Ph.D. programs in Actuarial Science	\$1488	\$750	✓Yes
Towson University – proposed Actuarial Science and Predictive Analytics M.S.	MD	Concentration in Actuarial Science and Risk Management	\$398	\$360	✓Yes

E. Relevance to the identity of Historically Black Institutions (HBIs)

This program will have no impact on the uniqueness and institutional identities and missions of HBIs.

F. Relevance to high-demand programs at Historically Black Institutions (HBIs)

¹³ <http://sps.columbia.edu/actuarial-science>

¹⁴ <http://math.gmu.edu/graduate/cert-in-actuarial.php>

¹⁵ http://www.fox.temple.edu/cms_academics/dept/risk-insurance-healthcare-management/undergraduate/risk-management-and-insurance/

The proposed program is not expected to impact high-demand programs at Historically Black Institutions.

Morgan State University, the only HBI which has an actuarial program, offers a [Bachelor of Science in Actuarial Science](#) degree via their Mathematics program. Comparatively, the proposed Master of Science in Actuarial Science and Predictive Analytics will be the only program of its kind and the only graduate level Actuarial Science program in Maryland. This means the proposed master's program covers a very different program curriculum than Morgan State University's bachelor's program and is not expected to impact the program at Morgan State University.

G. Adequacy of curriculum design and delivery to related learning outcomes

The Master of Science in Actuarial Science and Predictive Analytics (ASPA) will prepare students to succeed in a market landscape that has greatly adopted risk management practices and data analytics. The proposed program will combine theory, practice, and predictive modeling, providing students with critical and analytical tools that will enable them to have the right skills to succeed in the marketplace and continue to be industry leaders.

Admission Requirements:

Admission to Master of Science degree in Actuarial Science and Predictive Analytics is competitive. The eligibility requirements to be admitted into the program are:

- A baccalaureate degree in mathematics or science or related field from a regionally accredited college or university verified on original transcripts, sent by the institution directly to Towson University. The student should be able to demonstrate a strong mathematics background through grades in mathematics courses; an undergraduate B.S. thesis focused on mathematics, sciences, or risk analysis; or work experience involving actuarial science. GPA (Grade Point Average): at least 3.0 (on 4.0 scale) on the last two years of the baccalaureate degree.
- The applicant's undergraduate training must have included at least three terms of calculus, calculus based probability, mathematical statistics, and linear algebra. Students with any deficiency in their mathematical background may be admitted conditionally if they are willing to correct such deficiency.
- Completion of either SOA (Society of Actuaries) Exam or GRE (Graduate Record Exam).
- Students who received their degree outside the United States must provide official verification of their English competency by submitting an English assessment report of their IELTS, TOEFL or other Towson University-approved testing system. Students must meet the standards set by Towson University to be admitted into the program.

- Passage of the first professional examination (Exam P) sponsored by the Society of Actuaries and the Casualty Actuarial Society may be considered as a substitute for college mathematics requirements, subject to department approval.

Degree Requirements:

The student is required to successfully complete at least 10 courses (Students may need to take more than 10 courses if prerequisites are not met) and **pass at least two Society of Actuaries professional exam (before or during the graduate study)**.

10-course (a minimum of 30 units) requirement is indicated below:

1. At least six courses from List A
2. At least four courses from List B
3. At most three 500-level courses from List A or List B will count toward the degree

List A

Math 512	Theory of Interest	4
Math 538	Long-Term Actuarial Models I	3
Math 542	Short Term Actuarial Models	4
Math 548	Long-Term Actuarial Models II	3
Math 585	Mathematical Finance	3
Math 586	Risk Management & Financial Engineering	3
Math 639	Loss Models	4
Math 641	Enterprise Risk Management	3
Math 642	Credibility and Simulation	3
Math 643	Computational Methods of Mathematical Finance	3
Math 644	Mathematics of Financial Derivatives	3
Math 688	Topics in Actuarial Science and Risk Management	3

List B

Math 533	Applied Regression and Time Series Predictive Modeling	4
Math 632	Computational Stochastics Modeling	3
Math 634	Time Series Analysis and Forecasting	3
Math 638	Applied Multivariate Statistical Analysis	3
Math 647	Predictive Analytics	3
Math 688	Topics in Actuarial Science and Risk Management	3

The New Courses and Existing Courses

New Courses: The following are 4 new courses for the Master of Science in Actuarial Science and Predictive Analytics.

- MATH 641 ERM – Enterprise Risk Management

Catalog Description: This course covers part of the syllabus of the Enterprise Risk Management exam offered by Society of Actuaries. It serves as an introduction to Enterprise Risk Management. It will define and categorize different types of risks an entity faces, and define an ERM framework. Ways to measure and quantify the risk, such as (principle based) Economic Capital, Value at Risk (VaR), and stress scenarios will be analyzed and compared. The course will conclude with applications of these methods in a case study of an insurance company and recent regulatory developments.

- Math 642 Credibility and Simulation

Catalog Description: The course covers subjects in modeling and simulations including: limited fluctuation (classical) credibility, Bayesian credibility, conjugate priors, Buhlmann and Buhlmann-Straub models, empirical Bayesian method in the nonparametric, and semiparametric cases.

- Math 647 Predictive Analytics

Catalog Description: The course covers the principles and methodologies in predictive modeling. The topics include prediction versus interpretation; assessing model accuracy; resampling methods; bootstrap; subset selection; shrinkage methods; dimension reduction methods; the logistic model; bagging; random forests; principal components analysis; clustering methods. R, SAS, SPSS or a similar software is used for real data analysis.

- MATH 688 Topics in Actuarial Science and Risk Management

Catalog Description: This course will cover various topics in Actuarial Science and Risk Management selected by the instructor. Selected topics include financial reporting, valuation, and management considerations for life insurance companies; capital and risk management, including securitization techniques in the insurance industry; worker's compensation programs and pricing; emerging techniques for use by actuaries; actuarial studies and communication techniques, and possibly other topics.

Redesigned and Retitled Courses:

- Math 512 Theory of Interest

Catalog Description: This courses covers mathematical theory and applications of key financial management concepts and procedures including money growth; force of interest; annuities; perpetuities; amortization; stocks; bonds; yield approximation

approaches; term structure of interest rates; swaps; determinants of interest; duration, convexity and asset matching.

- Math 537 Applied Regression and Time Series Predictive Modeling

Catalog Description: Simple and multiple regression, least squares estimates, hypothesis testing, confidence intervals and prediction intervals, model building methods and diagnostic checking. Non-seasonal time series models: autoregressive, moving-average and/or autoregressive integrated moving-average models, parameter estimation and forecasting. Minitab or a similar software is used for real data analysis.

- Math 538 Long-Term Actuarial Models I

Catalog Description: Theory and applications of long-term actuarial mathematics in the area of life insurance, annuities and pensions. Topics include survival models, life table, present value random variables for contingent insurance and annuities, future loss random variables, actuarial equivalence principle and other principles for pricing life insurance and annuity contracts, benefit reserves.

- Math 542 Short Term Actuarial Models

Catalog Description: This course covers part of the syllabus of the Short-Term Actuarial Mathematics exam offered by Society of Actuaries. Topics including severity models, frequency models, aggregate models, risk measures, construction and selection of parametric models, insurance and reinsurance coverages, and pricing and reserving for short-term insurance coverages.

- Math 548 Long-Term Actuarial Models II

Catalog Description: This course covers the second part of the syllabus of the Long-Term Actuarial Mathematics offered by the Society of Actuaries. Topics include future loss random variables; reserves for traditional life insurances and annuities; multiple state models including multiple decrements models; multiple life functions; estimates of survival models; profit testing; pension plans and retirement benefits

- Math 586 Risk Management & Financial Engineering

Catalog Description: Mean-variance portfolio theory, assets pricing models, market efficiency and behavioral finance, investment risk and project analysis, capital structures, Cash flow engineering, Monte Carlo methods, statistical analysis of simulated data, risk measures, framework for fixed income engineering, portfolio management, change of measures and Girsanov Theorem and tools for volatility engineering. Computer laboratory activities throughout.

- Math 634 Time Series Analysis and Forecasting

Catalog Description: An introduction to statistical models for time series analysis and forecasting. Topics include time series decompositions, exponential smoothing, dynamic regression, spectral analysis and filtering. A variety of models will be discussed including the Holt, Holt-Winters, ARMA, ARIMA, SARIMA, and state-space models. R, SAS, SPSS or a similar software is used for real data analysis.

Existing Courses: Course descriptions are provided in the Towson University Catalog and in Appendix 2.

- Math 585 Mathematical Finance
- Math 639 Loss Models
- Math 632 Computational Stochastics Modeling
- Math 638 Applied Multivariate Statistical Analysis
- Math 643 Computational Methods of Mathematical Finance
- Math 644 Mathematics of Financial Derivatives

Program Goals and Outcomes:

The intent of the proposed Master of Science in Actuarial Science and Predictive Analytics program is to prepare students with a foundational understanding in predictive analytics to ensure students stay current in the evolving actuarial profession, prepare them for tomorrow's challenge, and "continues to meet the needs of employers and other users of actuarial services".¹⁶ At the completion of the program, students are expected to demonstrate the following student learning outcomes:

- Assess and elucidate the theoretical and historical foundations of actuarial science and predictive analytics.
- Choose and defend the choice of mathematical models and technologies to conduct predictive analyses, financial evaluations, and risk management assessments
- Compare and contrast the principles and procedures of various methodologies to implement practical and technical aspects of actuarial science and predictive analytics
- Design and conduct a financial project, analyze the findings, and convey the results through professional oral and written reports and graphics that reflect actuarial science standards

¹⁶ Society of Actuaries: Plain Talk: Curriculum Review <https://www.soa.org/board-announcements/2016/plain-talk-curriculum-review/>

Appendix 3 demonstrates the alignment of learning objectives, graduate student characteristics, and the curricular map with the program goals.

H. Adequacy of articulation

Not Applicable.

I. Adequacy of faculty resources

The undergraduate Actuarial Science and Risk Management program at Towson University is one of the best actuarial science programs in the country – it is the only program in Maryland recognized as a Center of Actuarial Excellence (CAE) by the SOA and is 1 of only 17 CAEs in the entire country.

Additionally, the ASRM faculty members at Towson are strongly positioned to continue providing exceptional education to students. With two Fellow of Society of Actuaries (FSA) among the three tenure-track or tenured Actuaries Science faculty members, three have expertise in the area of statistics and predictive analytics field, and one has expertise in financial mathematics. Towson university faculty have the experience, expertise, and knowledge to provide a strong program for students and to attract outstanding prospective students.

The strong program reputation and strong faculty team serve as a great opportunity and exceptional foundation for the Master's program. The new graduate program will provide exciting synergies with the existing nationally recognized undergraduate program.

The proposed Master of Science in Actuarial Science and Predictive Analytics leverages our existing Master of Science in Applied and Industrial Mathematics. Courses are drawn from the existing course list, active and inactive courses from the catalog, and new courses that will provide students more choice. The department could offer one more graduate course per semester due to more students, and the programs share some faculty resources—maximizing the efficiency and effectiveness of the offerings.

Based on projected student enrollment numbers, the proposed program will not require new faculty resources in the first two years. We plan to leverage existing five hundred level courses and six hundred level courses to fulfill the first two years' requirements.

Starting in the third year, we anticipate the proposed program will reach full capacity and will need one half new full-time equivalent, tenure-track position in the Department of Mathematics at the beginning and increasing to one full time position over time. This new position will support the teaching of a full capacity program and support much needed mentorship in graduate research projects. The addition of the new position will also give the entire faculty team sufficient capacity to support the challenging research requirements needed for Towson University to maintain the Centers of Actuarial Excellence distinction from the Society of Actuaries.

All courses will be taught by full-time TU faculty (addresses minimum requirements detailed in COMAR 13B.02.03.11), and no courses will be taught in an off-campus program (addresses COMAR 13B.02.03.20). The faculty resources table follows below:

Faculty Resources					
	FTE	Highest Degree Earned/Field of Study	Rank	Status (Full-time or Part-time)	Courses Teaching
Existing Faculty					
Instructor 1	0.125	PhD/Financial Mathematics	Full/ Associate/ Assistant	Full-time	Math 642 Credibility and Simulation
Instructor 2	0.125	PhD/Financial Mathematics	Full/ Associate/ Assistant	Full-time	Math 644 Mathematics of Financial Derivatives
Instructor 3	0.175	PhD/Actuarial Science	Full/ Associate/ Assistant	Full-time	Math 641 Enterprise Risk Management Math 792 Internship II
Instructor 4	0.125	PhD/Actuarial Science	Full/ Associate/ Assistant	Full-time	Math 688 Topics in Actuarial Science and Risk Management
Instructor 5	0.125	PhD/Statistics	Full/ Associate/ Assistant	Full-time	Math 632 Computational Stochastics Modeling
Instructor 6	0.125	PhD/Statistics	Full/ Associate/ Assistant	Full-time	Math 634 Computational Spectral Analysis and Time Series
Instructor 7	0.125	PhD/Statistics	Full/ Associate/ Assistant	Full-time	Math 638 Applied Multivariate Statistical Analysis

Faculty Resources					
	FTE	Highest Degree Earned/Field of Study	Rank	Status (Full-time or Part-time)	Courses Teaching
Instructor 8	0.175	PhD/Statistics	Full/ Associate/ Assistant	Full-time	Math 647 Predictive Analytics Math 791 Internship I
New Faculty					
Instructor I	1	PhD/Actuarial Science	Assistant	Full-Time	Math 639 Loss Models Math 643 Computational Methods of Mathematical Finance Math 641 Enterprise Risk Management Math 642 Credibility and Simulation Math 791/792 Masters Internship I/II

J. Adequacy of library resources

Albert S. Cook Library at Towson University currently provides access to scholarly databases with content that, in addition to supporting the general needs of the Department of Mathematics, supports the study of Actuarial Science and Predictive Analytics. Namely, databases including Business Source Premier, Accounting & Tax, and Emerald provide access on and off-campus to journals including Annals of Actuarial Science, Risk Management, and the Journal of Risk and Insurance. Articles not immediately available within the library's collection can be requested via Interlibrary Loan. Bill Helman is the designated librarian for Mathematics and can assist with collection development, teaching, and research needs.

Due to the variety of professional exam study materials and related books required for the program of study, an estimated \$1,000 annually is requested to initiate and maintain the library resources for future students in the proposed program.

K. Adequacy of physical facilities, infrastructure and instructional equipment

This program will require no additional physical facilities, infrastructure or instructional equipment. The program will leverage existing classroom space and optimize timing of courses to offer the proposed program without requiring additional facilities, infrastructure, or instructional equipment.

L. Adequacy of financial resources with documentation

The proposed program requires minimal additional resources as it is built upon the existing ASRM program. We do not anticipate needing any additional funding to cover the first two years of the program. While we anticipate needing a new faculty member starting in year 3, the expected tuition from students in the proposed program will be enough to cover the salary and benefits of a new faculty member. Please see details in Table 1: Resources and Table 2: Expenditures.

M. Adequacy of provisions for evaluation of program

Ongoing evaluation of the proposed program covers 3 main areas including: faculty performance, student success, and curriculum suitability. The evaluation provisions will build upon procedures already in place with the successful undergraduate program and strive for continued excellence.

Faculty:

Faculty of the Master of Science in the Actuarial Science and Predictive Analytics (ASPA) will be reviewed regularly, according to the Towson University policy for faculty review: Assistant Professors are required to have two peer evaluations of their teaching each year; the courses of Associate and Full Professors are evaluated twice in every five year period. In addition, the Director of the ASPA program will consult with faculty members teaching in the program at the beginning and end of each semester. Review of faculty by the Department Chair includes review of course syllabi, one-on-one discussions with faculty member of students and teaching strategies, and gathering feedback from students enrolled in each class.

Additionally, faculty will leverage tools and resources offered by The Society of Actuaries (SOA), the largest professional organization that represents American actuaries. The SOA regularly provides the professional development opportunities, review, and evaluation of its members. The faculty roster also includes two Fellow of Society of Actuaries (FSA) who are subject to the SOA Continued Professional

Development (CPD) requirement that supports faculty self-evaluation and continued professional development.

Courses in the ASPA will be evaluated each semester, utilizing the online student evaluation system currently employed by Towson University for all of its classes. Students' course evaluations and peer classroom observations will enhance and improve faculty in the ASPA teaching.

Student:

Student performance and outcomes will be assessed by many metrics including:

- Records of admission to advanced degree program, such as Ph.D. program.
- Number of the Society of Actuaries professional exams passed by students in the graduate program.
- Faculty evaluation of students' internship experiences combined with recommendations from industry professional.
- Number of graduates who become Actuarial Associates and Actuarial Fellows with the Society of Actuaries.
- Records of job offers and career advancement.

All students in the graduate program must receive a grade of B or better for all courses (courses may not be taken pass-fail)

Curriculum:

The ASRM faculty committee will review the curriculum regularly. The Society of Actuaries (SOA) recommendation¹⁷ will be taken into serious consideration during the curriculum review process. Appendix 4 includes the TU Assessment Plan for the ASPA master's program.

N. Consistency with the State's minority student achievement goals

The proposed new ASPA program is consistent with Goal 3 of the Maryland State Plan for Higher Education, Diversity. In fact, the proposed program is aligned with and partners with the two biggest Actuarial Professional organizations, Casualty Actuaries Society (CAS) and Society of Actuaries (SOA), to deliver on diversity and inclusion goals. The CAS/SOA Joint Committee on Career Encouragement & Actuarial Diversity, for example, started over 30 years ago to address lack of diversity in the actuarial profession and promote a diverse actuarial profession by many ways such as, awareness in national and international conferences, scholarships to college students, summer programs for minority high school students, and reimbursement program rewarding the diversity candidates who pass Exam P/1 and or FM/2.¹⁸ The new

¹⁷ Society of Actuaries; Centers of Actuarial Excellence criteria: <https://www.soa.org/cae/>

¹⁸ Society of Actuaries: <https://www.soa.org/about/diversity-inclusion/default/>

program will continue to partner with both organizations to continue delivering on actions such as these to address diversity and inclusion.

O. Relationship to low productivity programs identified by the Commission

Not Applicable

P. If proposing a distance education program, please provide evidence of the Principles of Good Practice

Not Applicable

Q. Program Resources and Expenditures Tables

TABLE 1: RESOURCES					
Fill in items highlighted in blue only					
Resources Categories	(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)
1. Reallocated Funds ¹	0	0	0	0	0
2. Tuition/Fee Revenue ²	90,510	183,800	248,655	252,465	384,480
a. Annual Full-time Revenue of New Students					
Number of Full-time Students	5	10	15	15	25
Annual Tuition Rate	\$9,096	\$9,278	\$9,463	\$9,653	\$9,846
Subtotal Tuition	\$45,480	\$92,780	\$141,945	\$144,795	\$246,150
Annual Fees	\$2,970	\$2,970	\$2,970	\$2,970	\$2,970
Subtotal Fees	\$14,850	\$29,700	\$44,550	\$44,550	\$74,250
Total Full-time Revenue of New Students	\$60,330	\$122,480	\$186,495	\$189,345	\$320,400
b. Annual Part-time Revenue					
Number of Part-Time Students	5	10	10	10	10
Credit Hour Tuition Rate	\$379	\$387	\$394	\$402	\$410
Annual Fees Per Credit Hour	\$124	\$124	\$124	\$124	\$124
Annual Credit Hours Per Student	12	12	12	12	12
Subtotal Tuition	\$22,740	\$46,440	\$47,280	\$48,240	\$49,200
Subtotal Fees	\$7,440	\$14,880	\$14,880	\$14,880	\$14,880
Total Part Time Revenue	\$30,180	\$61,320	\$62,160	\$63,120	\$64,080
3. Grants, Contracts & Other Sources ³	\$0	\$0	\$0	\$0	\$0
4. Other Sources	\$0	\$0	\$0	\$0	\$0
TOTAL (Add 1 - 4)	\$90,510	\$183,800	\$248,655	\$252,465	\$384,480

¹ Whenever reallocated funds are included among the resources available to new programs, the following information must be provided in a footnote: origin(s) of reallocated funds, impact of the reallocation on the existing academic program(s), and manner in which the reallocation is consistent with the institution's strategic plan.

² This figure should be a realistic percentage of tuition and fees which will be used to support the new program. Factors such as indirect costs linked to new students and the impact of enrolling continuing students in the new program should be considered when determining the percentage.

³ Whenever external funds are included among the resources, the following information must be provided in a footnote: source of the funding and alternative methods of funding the program after the cessation of external funding.

TABLE 2: EXPENDITURES

Fill in blue shaded areas only.

Expenditure Categories	(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)
1. Total Faculty Expenses	\$0	\$0	\$66,500	\$68,495	\$141,100
(b + c below)					
a. #FTE	0.0	0.0	0.5	0.5	1.0
b. Total Salary			50,000	51,500	106,090
c. Total Benefits	0	0	16,500	16,995	35,010
2. Total Administrative Staff Expenses	0	0	0	0	0
(b + c below)					
a. #FTE					
b. Total Salary					
c. Total Benefits	0	0	0	0	0
3. Total Support Staff Expenses	0	0	0	0	0
(b + c below)					
a. #FTE					
b. Total Salary					
c. Total Benefits	0	0	0	0	0
4. Equipment					
5. Library	1,000	1,000	1,000	1,000	1,000
6. New or Renovated Space					
7. Other Expenses					
TOTAL (1-7)	\$1,000	\$1,000	\$67,500	\$69,495	\$142,100

Appendix 1 Maryland Long Term Occupational Projections (2014 - 2024)¹⁹

Occupation (keyword search)

Contains "Actuaries"

Number of Openings

All values

Percent Change

All values

Occupation	2014	2024	Change	Pct Change
Actuaries	522.0	653.0	131.0	25.10%



**Department of Labor, Licensing and Regulation
Division of Workforce Development and Adult Learning
Office of Workforce Information and Performance**

1100 North Eutaw Street
Baltimore, Maryland 21201
410-767-2250

DLWDALLMI-DLLR@maryland.gov



¹⁹Department of Labor Licensing and Regulation.
<https://www.dllr.state.md.us/lmi/iandoproj/maryland.shtml>. (Captured Dec 6, 2016).

Appendix 2: Course Descriptions

- Math 585 Mathematical Finance

Catalog Description: Mathematical theory, computation and practical application of derivatives in managing financial risk. Parity and option relationships, binomial option pricing, the Black-Scholes equation and formula, option Greeks, market-making and delta-hedging, exotic options, lognormal distribution, Brownian motion and Ito's lemma, interest rate models. Computer laboratory activities throughout.

- Math 632 Computational Stochastics Modeling

Catalog Description: Computing expectations and probabilities by conditioning. Markov chains: classification of states, limiting probabilities, gambler's ruin problems, algorithmic efficiency, branching process, time-variable Markov chains, continuous-time Markov chains, birth and death processes, Kolmogorov differential equations, uniformization. Renewal theory and its applications.

- Math 638 Applied Multivariate Statistical Analysis

Catalog Description: A brief review of vector and matrix algebra and an introduction to applications of multivariate statistical methods. Multivariate normal distribution and its properties, inference for mean vector of a multivariate normal distribution, and simultaneous inference for components of the mean vector. Principle components, factor analysis, and discrimination & classifications. The course introduces many applications of the topics related to real world problems in the fields of engineering, sciences, and business. Minitab or a similar software is used for real data analysis.

- Math 639 Loss Models

Catalog Description: Severity models, frequency models, aggregate models, survival models, construction of parametric models, and credibility models.

- Math 643 Computational Methods of Mathematical Finance

Catalog Description: Computation techniques involving tree method, finite difference scheme, Monte Carlo simulation, term structure fitting and modeling, financial derivative pricing, the Greeks of options, Capital Asset Pricing Model, Value-at Risk calculation. Software package such as Mathematica or Excel will be used.

- Math 644 Mathematics of Financial Derivatives

Catalog Description: Modern pricing theory for financial derivatives, stochastic differential equations, Ito formula, martingales, Girsanov Theorem, Feynman-Kac PDE, term structure, Interest-Rate models and derivatives, optimal stopping and American options.

Appendix 3: Alignment of Program Goals with Learning Outcomes, Graduate Student Characteristics, and Curricular Map

Program Goals	Learning Outcomes	Towson Graduates Characteristics	Goal Curricular Alignment
Assess and elucidate the theoretical and historical foundations of actuarial science and predictive analytics	Understand key steps and considerations in building a predictive analytics model.	Information literacy and technological competency	Math 538 Actuarial Models
	Understand ethical and professional considerations with regard to data and modeling.	Effective communication	Math 542 Actuarial Model Construction
	Identify and apply actuarial knowledge/concepts within a broader context.	Critical analysis and reasoning	Math 548 Advance Actuarial Models
	Communicate results more efficiently with others, including non-actuaries.	Specialized knowledge in defined fields	Math 632 Computational Stochastics Modeling
	Formulate and execute a schedule and plan for project completion, and anticipate, assess, and adjust continually throughout the process.	Working in multifaceted work environments	Math 634 Computational Spectral Analysis and Time Series
	Identify the business problem, understand how the available data relates to possible analyses, and use the information to propose models.	Local and global citizenship and leadership	Math 638 Applied Multivariate Statistical Analysis
	Demonstrate understanding of course materials and vocabulary through analysis, critique, self-reflection, and revision.		Math 639 Loss Models
			Math 647 Predictive Analytics
		Math 642 Credibility and Simulation	
		Math 688 Topics in Actuarial Science and Risk Management	

Program Goals	Learning Outcomes	Towson Graduates Characteristics	Goal Curricular Alignment
<p>Choose and defend the choice of mathematical models and technologies to conduct predictive analyses, financial evaluations, and risk management assessments</p>	<p>Understand the types of risks faced by an entity and be able to identify, quantify, manage, and analyze these risks.</p> <p>Be able to evaluate and understand the concept and importance of risk models.</p> <p>Understand how the risks faced by an entity can be quantified.</p> <p>To be able to use metrics to measure risk.</p> <p>Understand the approaches for managing risks</p> <p>Understand how an entity makes decisions about appropriate techniques.</p> <p>Understand the concept of economic capital.</p>	<p>Information literacy and technological competency</p> <p>Effective communication</p> <p>Critical analysis and reasoning</p> <p>Specialized knowledge in defined fields</p> <p>Working in multifaceted work environments</p> <p>Local and global citizenship and leadership</p>	<p>Math 538 Actuarial Models</p> <p>Math 542 Actuarial Model Construction</p> <p>Math 548 Advance Actuarial Models</p> <p>Math 585 Mathematical Finance</p> <p>Math 586 Risk Management & Financial Engineering</p> <p>Math 639 Loss Models</p> <p>Math 643 Computational Methods of Mathematical Finance</p> <p>Math 644 Mathematics of Financial Derivatives</p> <p>Math 641 Enterprise Risk Management</p> <p>Math 642 Credibility and Simulation</p> <p>Math 688 Topics in Actuarial Science and Risk Management</p>

Program Goals	Learning Outcomes	Towson Graduates Characteristics	Goal Curricular Alignment
<p>Compare and contrast the principles and procedures of various methodologies to implement practical and technical aspects of actuarial science and predictive analytics</p>	<p>Create multiple models for business problems, critically analyze them, and monitoring and validating models, select the “best” model.</p> <p>Demonstrate how each of the financial and non-financial risks faced by an entity can be amenable to quantitative analysis including an explanation of the advantages and disadvantages of various techniques such as Value at Risk (VaR), stochastic analysis, and scenario analysis.</p> <p>Conduct exploratory data analysis to identify key relationships that inform initial model selection</p> <p>List and employ the various methods of research that can be conducted to reach the decisions.</p>	<p>Information literacy and technological competency</p> <p>Effective communication</p> <p>Critical analysis and reasoning</p> <p>Specialized knowledge in defined fields</p>	<p>Math 537 Applied Regression and Time Series Predictive Modeling</p> <p>Math 585 Mathematical Finance</p> <p>Math 586 Risk Management & Financial Engineering</p> <p>Math 632 Computational Stochastics Modeling</p> <p>Math 634 Computational Spectral Analysis and Time Series</p> <p>Math 638 Applied Multivariate Statistical Analysis</p> <p>Math 643 Computational Methods of Mathematical Finance</p> <p>Math 644 Mathematics of Financial Derivatives</p> <p>Math 647 Predictive Analytics</p> <p>Math 641 Enterprise Risk Management</p>

Program Goals	Learning Outcomes	Towson Graduates Characteristics	Goal Curricular Alignment
<p>Design and conduct a financial project, analyze the findings, and convey the results through professional oral and written reports and graphics that reflect actuarial science standards</p>	<p>Demonstrate understanding of core concepts of actuarial science and predictive analytics, critique, self-reflection, and revision.</p> <p>Define a project’s scope and purpose, and specify its intended audience.</p> <p>Clearly and tailor communication ideas, questions, problems, and solutions in both verbally and in writing.</p> <p>Write, produce, and present the research and project concepts, processes, and results to peers and professionals.</p>	<p>Information literacy and technological competency</p> <p>Effective communication</p> <p>Critical analysis and reasoning</p>	<p>Math 538 Actuarial Models</p> <p>Math 542 Actuarial Model Construction</p> <p>Math 548 Advance Actuarial Models</p> <p>Math 585 Mathematical Finance</p> <p>Math 586 Risk Management & Financial Engineering</p> <p>Math 639 Loss Models</p> <p>Math 647 Predictive Analytics</p> <p>Math 641 Enterprise Risk Management</p> <p>Math 642 Credibility and Simulation</p> <p>Math 688 Topics in Actuarial Science and Risk Management</p>

Appendix 4: Assessment Plan

Curricular Alignment with Student Learning Outcomes (Objectives)

(only for academic Programs)

✓ = outcomes will be covered in the course; × = assessment data will be collected in the course.

	Assess and elucidate the theoretical and historical foundations of actuarial science and predictive analytics	Choose and defend the choice of mathematical models and technologies to conduct predictive analyses, financial evaluations, and risk management assessments	Compare and contrast the principles and procedures of various methodologies to implement practical and technical aspects of actuarial science and predictive analytics	Design and conduct a financial project, analyze the findings, and convey the results through professional oral and written reports and graphics that reflect actuarial science standards
Math 512 Theory of Interest			✓	
Math 533 Applied Regression and Time Series Predictive Modeling	✓ ×		✓ ×	
Math 538 Long-Term Actuarial Models I	✓	✓		✓ ×
Math 542 Short Term Actuarial Models	✓	✓		✓
Math 548 Long-Term Actuarial Models II	✓	✓		✓
Math 585 Mathematical Finance		✓ ×	✓ ×	✓
Math 586 Risk Management & Financial Engineering		✓	✓	✓
Math 632 Computational Stochastics Modeling	✓		✓	
Math 634 Computational Spectral Analysis and Time Series	✓		✓	
Math 638 Applied Multivariate Statistical Analysis	✓		✓	
Math 639 Loss Models	✓	✓		✓
Math 643 Computational Methods of Mathematical Finance		✓	✓	
Math 644 Mathematics of Financial Derivatives		✓	✓	

	Assess and elucidate the theoretical and historical foundations of actuarial science and predictive analytics	Choose and defend the choice of mathematical models and technologies to conduct predictive analyses, financial evaluations, and risk management assessments	Compare and contrast the principles and procedures of various methodologies to implement practical and technical aspects of actuarial science and predictive analytics	Design and conduct a financial project, analyze the findings, and convey the results through professional oral and written reports and graphics that reflect actuarial science standards
Math 647 Predictive Analytics	✓ x		✓ x	✓ x
Math 641 Enterprise Risk Management		✓ x	✓	✓
Math 642 Credibility and Simulation	✓ x	✓ x		✓ x
Math 688 Topics in Actuarial Science and Risk Management	✓ x	✓ x	✓ x	✓ x

Student Learning Outcomes (Objectives) & Assessment Measures
(academic programs and core courses)

	Measure 1 Brief Description of Measure	Measure 2 Brief Description of Measure
Assess and elucidate the theoretical and historical foundations of actuarial science and predictive analytics	Math 533 final exam Math 647 Predictive Analytics final exam Math 632 final exam or Math 634 final exam or Math 638 final exam or Math 642 Credibility and Simulation final exam	Students will be assessed on both oral presentation and written reports for the projects in the Math 688 Topics in Actuarial Science and Risk Management.
Choose and defend the choice of mathematical models and technologies to conduct predictive analyses, financial evaluations, and risk management assessments	Math 585 final exam Math 641 Enterprise Risk Management final exam Math 639 final exam or Math 634 final exam or Math 644 final exam or Math 642 Credibility and Simulation final exam	Students will be assessed on both oral presentation and written reports for the projects in the Math 688 Topics in Actuarial Science and Risk Management.
Compare and contrast the principles and procedures of various methodologies to implement practical and technical aspects of actuarial science and predictive analytics	Math 533 final exam Math 585 final exam Math 647 Predictive Analytics final exam Math 641 Enterprise Risk Management final exam	Pass SOA Exam P Pass SOA Exam FM
Design and conduct a financial project, analyze the findings, and convey the results through professional oral and written reports and graphics that reflect actuarial science standards	Math 533 Project Math 585 Project or	Students will be assessed on both oral presentation and written reports for the projects in the Math 688 Topics in Actuarial Science and Risk Management.

Student Learning Outcomes (Objectives) & Targeted Performance
(academic programs and core courses)

	Measure 1 Targeted Performance Level for Achievement	Measure 2 Targeted Performance Level for Achievement
Assess and elucidate the theoretical and historical foundations of actuarial science and predictive analytics	80% of correct answers = meet standard; 85% of correct answers = exceed standard. At least 80% of exams should score 80% or higher to indicate that the learning outcome has been met.	At least 80% of the students in the Math 688 Topics in Actuarial Science and Risk Management will be expected to obtain an 80% score for the written project. At least 80% of the students in the Math 688 presentation meet standard.
Choose and defend the choice of mathematical models and technologies to conduct predictive analyses, financial evaluations, and risk management assessments	80% of correct answers = meet standard; 85% of correct answers = exceed standard. At least 80% of exams should score 80% or higher to indicate that the learning outcome has been met.	At least 80% of the students in the Math 688 Topics in Actuarial Science and Risk Management will be expected to obtain an 80% score for the written project. At least 80% of the students in the Math 688 presentation meet standard.
Compare and contrast the principles and procedures of various methodologies to implement practical and technical aspects of actuarial science and predictive analytics	80% of correct answers = meet standard; 85% of correct answers = exceed standard. At least 80% of exams should score 80% or higher to indicate that the learning outcome has been met.	100% of the students graduate from the program pass at least two SOA exams including Exam P and Exam FM
Design and conduct a financial project, analyze the findings, and convey the results through professional oral and written reports and graphics that reflect actuarial science standards	80% in project grade = meet standard; 85% in project grade= exceed standard or All categories of the presentation must be "acceptable" or better = meet standard; Meet the standard + at least two categories rated better than "acceptable" = exceed the standard.	At least 80% of the students in the Math 688 Topics in Actuarial Science and Risk Management will be expected to obtain an 80% score for the written project. At least 80% of the students in the Math 688 presentation meet standard.

Student Learning Outcome & Collection Cycle

(academic programs and core courses)

	Measure 1 Collection Cycle	Measure 2 Collection Cycle
Assess and elucidate the theoretical and historical foundations of actuarial science and predictive analytics	May each year	May each year
Choose and defend the choice of mathematical models and technologies to conduct predictive analyses, financial evaluations, and risk management assessments	May each year	May each year
Compare and contrast the principles and procedures of various methodologies to implement practical and technical aspects of actuarial science and predictive analytics	May each year	May each year

Design and conduct a financial project, analyze the findings, and convey the results through professional oral and written reports and graphics that reflect actuarial science standards	May each year	May each year
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EXAMPLE COURSE PLANS: Part-time Schedules

Part-time example 1 (2 courses in fall and spring, one course in summer)

<i>Meet Mathematical Admission Requirements</i>		
Year 1		
Fall	Spring	Summer
Math 512 Math 538	Math 533 Math 688 Topics in Actuarial Science and Risk Management	Math 642 Credibility and Simulation
Year 2		
Fall	Spring	Summer
Math 639 Math 641 Enterprise Risk Management	Math 638 Math 647 Predictive Analytics	Math 634

Part-time example 2 (2 courses in fall and spring, one course in summer)

<i>Meet Mathematical Admission Requirements</i>		
Year 1		
Fall	Spring	Summer
Math 585 Math 641 Enterprise Risk Management	Math 533 Math 688 Topics in Actuarial Science and Risk Management	Math 642 Credibility and Simulation
Year 2		
Fall	Spring	Summer
Math 639 Math 634	Math 643 Math 647 Predictive Analytics	Math 634

EXAMPLE COURSE PLANS: Full-time Schedules

Full-time example 1 (3 courses in fall and spring, one course in summer)

<i>Meet Mathematical Admission Requirements</i>		
Year 1		
Fall	Spring	Summer
Math 512 Math 538 Math 533	Math 638 Math 647 Predictive Analytics Math 688 Topics in Actuarial Science and Risk Management	Math 642 Credibility and Simulation
Year 2		
Fall	Spring	Summer
Math 634 Math 639 Math 641 Enterprise Risk Management		

Full-time example 2 (3 courses in fall and spring, one course in summer)

<i>Meet Mathematical Admission Requirements</i>		
Year 1		
Fall	Spring	Summer
Math 533 Math 542 Math 585	Math 643 Math 647 Predictive Analytics Math 688 Topics in Actuarial Science and Risk Management	Math 642 Credibility and Simulation
Year 2		
Fall	Spring	Summer
Math 634 Math 639 Math 641 Enterprise Risk Management		



Symeon Williams
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February 23, 2018

Dr. Min Deng
Professor and Director
Actuarial Science and Risk Management Program
Mathematics Department
Towson University
8000 York Road
Towson, MD 21252-0001

RE: Master of Science in Actuarial Science and Predictive Analytics

To Whom It May Concern:

I strongly support the Towson University Mathematics Department proposal for a new Master of Science in Actuarial Science and Predictive Analytics degree program.

Transamerica supports a stronger actuarial community in the Baltimore region. This new ASPA Masters is seen as a continuation of the evolution of Towson University's leadership in the Mid-Atlantic region. Given that we have a close history with Towson, we realize that this will create a special opportunity for the graduates as well as employers who can rely on a quality candidate and future leader with a unique skill set.

I have seen first-hand the close ties that Towson's Actuarial Science and Risk Management has with the community of employers. My personal experiences with Towson have been through two different perspectives. This was as Chairman of a Towson board and as a local employer.

As Chairman for the Towson Actuarial Science and Risk Management Advisory Board, I am proud to be part of this fantastic program. The recognition from the Society of Actuaries of bestowing Towson as a Center of Actuarial Excellence continues to reward the hard work of the faculty, students, and community. As an advisory board, we strive to build on the momentum of these strong traditions and look to help in any way possible to further the strong ties that we have with Towson.

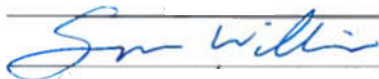
The ASRM board's charter states that our mission is to provide an external and durable structure of support for the program's success. We accomplish this through presentations, research topics, on-campus visits, on-site work visits, and general advice to the Actuarial Club and other alumni events to raise awareness and support. This also includes reviewing curriculum and advising how to make the best possible experience for the student while incorporating employer and industry demands. Seeing this ASPA Masters being offered is a way that Towson proactively sets the trend for future actuarial professions.

Separate from the ASRM board's efforts, Transamerica has shown support through annual financial contributions on behalf of the Transamerica Foundation.

As head of the Actuarial Development Program for Transamerica's Baltimore location, I speak for all managers in saying that we have had great success building a pipeline of Towson students through our internships and full-time opportunities. The best demonstration of our appreciation for Towson really comes down to hiring and rewarding Towson students with careers at Transamerica. We currently have at least 7 Towson alumni from first year new hires to credentialed FSAs. Having just finished our most recent bonus and merit process, I can say that for many years in a row, we have the majority of Towson students in the exceeding expectations category.

We look forward to the program's evolution and the continued successes of the Towson faculty and actuarial student body. We will be there along the way to help in any way that we can.

Sincerely,



Symeon Williams



Integrated
Financial Engineering

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December 19, 2017

Dr. Min Deng
Department of Mathematics
Towson University
8000 York Road
Towson, MD 21252

Dear Dr. Deng,

I am writing this letter to support of the proposed Master's Degree in Actuarial Science and Predictive Analytics. As the founder and CEO of Integrated Financial Engineering, I have been adamant about the need for dynamic curriculum based on constantly evolving financial engineering and actuarial science marketplace. After review the proposal, I am happy to see that the curriculum reflects the fast developing actuarial science and financial engineering fields. The proposed program combining the actuarial science with emerging data technology predictive analytics will be a unique Master Program in Maryland. I strongly believe that as the only Center of Actuarial Excellence (CAE) program in Maryland and one of 17 CAE programs recognized by Society of Actuaries in the nation, Towson University is able to make this proposed program a great success and supply graduates with the sophisticated skills urgently needed by the industry. Please keep me informed about the development of the Program.

Sincerely,

A handwritten signature in black ink, appearing to read 'Tyler Yang'.

Tyler Yang, Ph.D.
Chairman and CEO