

MEMORANDUM

TO: Members of the Academic and Research Advancement Committee
of the Board of Visitors

Michael J. Henry, Chair
Toykea S. Jones, Vice Chair
Lisa B. Smith (*ex-officio*)
Kay A. Kemper (*ex-officio*)
R. Bruce Bradley
Robert S. Corn
Unwanna B. Dabney
Jerri F. Dickseski
Alton J. Harris
Maurice D. Slaughter
Sebastian Kuhn (*Faculty Representative*)

FROM: Augustine O. Agho
Provost

DATE: November 26, 2018

The purpose of this memorandum is to provide you with background information for our meeting on Thursday, December 6, 2018. The committee will meet from 10:00-11:15 a.m. in the Kate and John R. Broderick Dining Commons, Committee Room A (Room 2203).

I. Approval of Minutes of the September 20, 2018 Meeting

The minutes of the September 20, 2018 meeting will be presented for approval as previously distributed.

II. Closed Session

The members of the Academic and Research Advancement Committee will receive information related to the items to be discussed in closed session.

III. Reconvene in Open Session and Vote on Resolutions

IV. Consent Agenda

Included in the consent agenda materials are resolutions recommending six faculty appointments, 18 administrative appointments, the appointment of three Louis I. Jaffe Professors, and seven emeritus/emerita appointments.

V. Vote on Consent Agenda Resolutions

VI. Regular Agenda

The regular agenda includes recommendations for a Bachelor of Science degree in Cybersecurity, a Master of Science degree in Data Science and Analytics, and approval to rename the School of Physical Therapy and Athletic Training the School of Rehabilitation Sciences.

VII. Vote on Regular Agenda Resolutions

VIII. Information Items

Information items include the report from the Provost and the report from the Vice President for Research. The report from the Vice President for Research will include a presentation on digital shipbuilding by Jennifer Michaeli, Assistant Professor of Engineering Technology.

IX. Topics of Interest to Board of Visitors Members

Committee members will have an opportunity to discuss topics of interest.

C: John R. Broderick
 Donna Meeks

OLD DOMINION UNIVERSITY
BOARD OF VISITORS
ACADEMIC AND RESEARCH ADVANCEMENT COMMITTEE
DECEMBER 6, 2018
AGENDA

10:00-11:15 a.m. – Kate and John R. Broderick Dining Commons, Committee Room A
(Room 2203)

- I. APPROVAL OF THE MINUTES OF SEPTEMBER 20, 2018
- II. CLOSED SESSION
- III. RECONVENE IN OPEN SESSION AND VOTE ON RESOLUTIONS
- IV. CONSENT AGENDA
 - A. Faculty Appointments (p. 4-5)
 - B. Administrative Appointments (p. 6-9)
 - C. Appointment of Louis I. Jaffe Professors (p. 10-12)
 - D. Emeritus/Emerita Appointments (p. 13-17)
- V. VOTE ON CONSENT AGENDA RESOLUTIONS
- VI. REGULAR AGENDA
 - A. Approval of a Bachelor of Science Degree in Cybersecurity (p. 18-45)
 - B. Approval of a Master of Science Degree in Data Science and Analytics (p. 46-75)
 - C. Approval to Rename the School of Physical Therapy and Athletic Training the School of Rehabilitation Sciences (p. 76)
- VII. VOTE ON REGULAR AGENDA RESOLUTIONS
- VIII. INFORMATION ITEMS
 - A. Report from the Provost
 - B. Report from the Vice President for Research
 1. Presentation on Digital Shipbuilding by Jennifer Michaeli, Assistant Professor of Engineering Technology
- IX. TOPICS OF INTEREST TO BOARD OF VISITORS MEMBERS

December 6, 2018

FACULTY APPOINTMENTS

RESOLVED that, upon the recommendation of the Academic and Research Advancement Committee, the Board of Visitors approves the following faculty appointments.

<u>Name and Rank</u>	<u>Salary</u>	<u>Effective Date</u>	<u>Term</u>
Dr. Kristi Costello Associate Professor of English	\$90,000	12/25/18	10 mos

Dr. Costello received a Ph.D. in English from Binghamton University and an M.A. in English and a B.A. in English Literature from Southeast Missouri State University. Previously she was Director of the Campus Writing Program and Composition, Director of the Writing Center, and Associate Professor of Composition, Writing Studies, and Creative Writing at Arkansas State University. (Salary includes \$15,000 for serving as Associate Chair of Writing Studies.)

Ms. Sheila K. List Instructor of Management Tenure Track	\$125,000	7/25/19	10 mos
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Ms. List received an M.S. in Psychology from Radford University, a B.A. in Psychology from Temple University and is expected to receive a Ph.D. in Business with a concentration in Management from Virginia Commonwealth University. Previously she was a Professor of Record in the Department of Management and Entrepreneurship at Virginia Commonwealth University. (Rank will be Assistant Professor if all requirements for the Ph.D. are completed by August 1, 2019.)

Ms. Sarojini Rao Instructor of Economics	\$26,223	12/25/18	5 mos
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Ms. Rao received an M.A. in Economics from the University of Chicago, a B.A. in Economics from Carleton College and is expected to receive a Ph.D. in Economics from the University of Chicago. Previously she was a Project Mentor, Lecturer and Teaching Assistant at the University of Chicago. (spring semester only)

Dr. Linda Thurby-Hay Clinical Associate Professor of Nursing	\$45,000	8/25/18	10 mos
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Dr. Thurby-Hay received a Doctorate of Nursing Practice from Rush University, a Master of Science from Virginia Commonwealth University and a Bachelor of Science in Nursing from Duquesne University. Previously she was a Clinical Nurse Specialist for Bon Secours Health System and an Affiliate Faculty at Virginia Commonwealth University. (half-time appointment)

Ms. Jennifer R. Vaziralli Lecturer of Management	\$53,000	10/25/18	10 mos
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Ms. Vaziralli received an M.B.A. from The Wharton School, University of Pennsylvania and a B.S. in Human Resource Management and a B.S. in Marketing Management from Virginia Polytechnic Institute and State University. Previously she was Chief Revenue Officer at Collage Group.

Dr. Honggeng Zhou Visiting Professor of Information Technology and Decision Sciences	\$60,000	12/25/18	5 mos
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Dr. Zhou received a Ph.D. in Business Administration and a Master of Arts in Business Administration from The Ohio State University, a Master of Science in Applied Statistics from the University of Memphis and a Bachelor of Science in Computer Science and Engineering from Zhejiang University. Previously he was a Professor in the School of Management at Zhejiang University. (spring semester only)

December 6, 2018

ADMINISTRATIVE FACULTY APPOINTMENTS

RESOLVED that, upon the recommendation of the Academic and Research Advancement Committee, the Board of Visitors approves the following administrative faculty appointments.

<u>Name and Rank</u>	<u>Salary</u>	<u>Effective Date</u>	<u>Term</u>
Ms. Tamara Barnes Transfer Admissions Counselor and Instructor	\$40,000	10/10/2018	12 mos

Ms. Barnes received a B.S. in Communication and a Master of Public Administration from Old Dominion University. Previously, she worked as a Transfer Evaluation Specialist for the University's Office of Admissions.

Ms. Kimberly Cain Assistant Director, Institutional Equity and Diversity and Assistant Professor	\$65,000	10/10/2018	12 mos
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Dr. Cain received a B.A. in Political Science from Old Dominion University and a J.D. from William and Mary Law School. Previously, she worked as a Legal Intern for the City of Hampton's Commonwealth Attorney's Office.

Ms. Kimberly Chavers Second Assistant Women's Rowing Coach and Assistant Instructor	\$38,250	9/25/2018	12 mos
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Ms. Chavers received a B.S. in Health Science from Marietta College and a D.P.T. in General Physical Therapy from Northeastern University. Previously, she worked as the Women's Summer Coach for the New York Athletic Club in Central Park, New York.

Ms. Danielle Dady Senior Research Compliance Coordinator, Office of Research and Assistant Instructor	\$65,000	10/1/2018	12 mos
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Ms. Dady received a B.S in Animal Science from the University of Connecticut. She holds certifications as a Certified Manager of Animal Resources (CMAR) and as a Registered

Ms. Courtney Kelly \$70,000 10/10/2018 12 mos
Assistant Director, Institutional Equity and
Diversity and Interim Title IX Coordinator
and Assistant Professor

Dr. Kelly received a B.A. in English from East Tennessee State University and a J.D. from Albany Law School. Previously, she worked as the Title IX Investigator for Norfolk State University.

Ms. Lisa Moser \$47,939 10/25/2018 12 mos
Coordinator of Undergraduate Studies,
Electrical and Computer Engineering
and Instructor

Ms. Moser received a B.A. in Business Administration from Ball State University and a Master of Business Administration from Old Dominion University. Previously, she served as the Academic Enrichment and Learning Communities Specialist for the University's Center for High Impact Practices.

Mr. James Palmer \$70,000 11/10/2018 12 mos
Senior Market Research Analyst
and Instructor

Mr. Palmer received a B.S. in Business Administration and an M.B.A. in Global Management from the University of Phoenix. Previously, he worked as the Senior College Research Analyst at Modesto Junior College and as an Information Technology Consultant for California State University at Stanislaus.

Ms. Lanah Stafford \$58,100 9/25/2018 12 mos
Director of CHIP Planning and Project Management,
Center for High Impact Practices and Instructor

Ms. Stafford received a B.S. in Political Science from the University of Wisconsin at Madison and an M.A. in Political Science from George Mason University. Previously, she was a Senior Research Associate for the University's Office of Institutional Effectiveness and Assessment.

Ms. Erica Watson \$55,500 10/25/2018 12 mos
Associate Director of Student Conduct and
Academic Integrity and Assistant Professor

Dr. Watson received a B.A. in Political Science from the University of Tennessee and a J.D. from the University of Tennessee College of Law. Previously, she worked as the Director of Student Conduct and Community Standards at Young Harris College.

Dr. Eric Weisel Executive Director of VMASC/Associate Vice President for Applied Research and Assistant Professor	\$200,000	11/10/2018	12 mos
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Dr. Weisel earned a B.S. in Mathematics from the United States Naval Academy, an M.S. in Operations Research from the Florida Institute of Technology, and a Ph.D. in Modeling, Simulation, and Visualization Engineering from Old Dominion University. Previously, he served as the Director of Applied Research for the University’s Office of Research. Prior to joining the University, Dr. Weisel worked in a variety of roles such as the Chief Scientist for Training and Simulation Solutions at General Dynamics and as the Founder and CEO for WernerAnderson, Inc., a technology research start-up firm.

Ms. Victoria West Coordinator, Operations and Aquatics and Instructor	\$38,500	11/10/2018	12 mos
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Ms. West received a B.A. in Psychology from Northwestern University and an M.A. in Kinesiology from California State University at Long Beach. Previously, she served as the Aquatics Director and Pool Operator for the U.S. Navy’s Department of Morale, Welfare, and Recreation in Virginia Beach, VA.

Ms. Kristin White Instructional Technology Specialist, Distance Learning and Instructor	\$55,000	11/10/2018	12 mos
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Ms. White received a B.S. in Physical and Health Education from Illinois State University, an M.A. in School Leadership from Concordia University at Chicago, and an M.S. in Educational Technology from Indiana State University. Previously, she worked as the Administrative Coordinator for the Office of Learning and Technology at the Rose-Hulman Institute of Technology in Terre Haute, IN.

Ms. Kimberley Williams Online Academic Program Planning Coordinator, Distance Learning and Instructor	\$52,000	11/10/2018	12 mos
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Ms. Williams received a B.A. in International Studies and Political Science from Virginia Tech and an M.P.A. from Old Dominion University. Previously, she worked as the Administrative Assistant to the Associate Vice President for Distance Learning at Old Dominion University.

December 6, 2018

APPOINTMENT OF LOUIS I. JAFFE PROFESSORS
COLLEGE OF ARTS AND LETTERS

RESOLVED that, upon the recommendation of the Academic and Research Advancement Committee, the Board of Visitors approves the appointment of the following individuals as Louis I. Jaffe Professors in Arts and Letters for 2018-2019 through 2022-2023. A summary of each person's career is included below for information purposes.

The Jaffe Professorship recognizes outstanding faculty scholars in the College of Arts and Letters who have demonstrated sustained excellence in teaching and/or research as well as a continuing, exemplary commitment to the university.

Luisa Igloria
Professor, Department of English

Dr. Igloria's nomination package was recommended by the Promotion and Tenure Committee for the Department of English, the Dean of the College of Arts and Letters, and endorsed by the University Named Chair Committee. She is well qualified for this distinction based on her scholarly productivity and achievements in teaching. She has published 16 books and chapbooks of poetry and non-fiction and a vast array of individual works. For the past eight years, she has made it her practice to write at least one poem every day, which are archived online in a series called, "Morning Porch Poems."

Dr. Igloria has been a superb teacher who inspires students in undergraduate and graduate literature and creative writing courses over her 23 years of service to ODU. She has developed new courses, such as the first Asian-American Literature course, and her assignments challenge new and advanced writers alike with inspiration from the works of a diverse array of writers and artists. As powerful evidence of her teaching effectiveness, many of her students have become published authors in their own right. Most notably, Dr. Igloria was the MFA thesis advisor to Ms. Natalie Diaz, who received a MacArthur "genius grant" fellowship in October 2018 for her poetry collection that evolved from her MFA thesis at ODU. Dr. Igloria has been nominated twice for the SCHEV Outstanding Faculty Award.

She has received international acclaim for her scholarly activities, beginning with First

Prize in the English Poetry category of the Palanca Awards in the Philippines in 1984. She was the first recipient of the Resurgence Poetry Prize for eco-poetry, awarded in London in December 2015. She has received notable poetry awards, such as the May Swenson Prize, the Ernest Sandeen Poetry Prize, the James Hearst Prize, and the 2018 Center for the Book Arts Letterpress Chapbook Prize. She engages with the local community through workshops at the Muse and is an active leader in the Hampton Roads Filipino community. In 2015, she received the John R. Broderick Diversity Champion Award and the Charles E. and Elizabeth Burgess Award for Research and Creativity. Her colleagues describe her as “an extraordinarily gifted artist and scholar, as well as a cherished and committed colleague.”

Proceeds from the Jaffe Professorship endowment funds will be used to provide a stipend of \$5,000 per year to Dr. Igloria in the academic years 2018-2019 through 2022-2023.

John Toomey
Professor, Department of Music

Professor Toomey’s nomination package was recommended by the Promotion and Tenure Committee for the Department of Music, the Dean of the College of Arts and Letters, and endorsed by the University Named Chair Committee. He is well qualified for this distinction in recognition of his scholarly productivity and achievements in teaching. He is internationally known as a jazz pianist and jazz artist. He has been a featured performer on more than a dozen CD’s and has written multiple award-winning soundtracks.

Professor Toomey has been recognized with notable teaching awards, including the ODU University Professor in 1999 for excellence in undergraduate teaching and the SCHEV Outstanding Faculty Award, the state’s highest teaching award, in 2000. He leads the Music Department’s Jazz Studies program and teaches multiple jazz-related courses. He strives to find innovative strategies to educate ODU music students and exposes them to all genres of jazz music. His connections with the artistic community and music industry have resulted in Master Classes being presented to students and the larger community. He has fostered the growth of a jazz emphasis area in the B.A. Music degree.

Professor Toomey is quite active in his scholarly pursuits. He is the Artistic Director and pianist for the Attucks Jazz Series, which is part of the Virginia Arts Festival and a notable example of well-established community engagement. At the Attucks, Professor Toomey and his jazz trio perform with at least five artists yearly. They have performed regularly with nationally and internationally acclaimed jazz artists including John Fedchock, Terrell Stafford, and Tierney Sutton. His department colleagues describe him as the “first call” jazz pianist in the region.

Professor Toomey has provided significant leadership and service to the department, serving nine years as chair and launching the building addition to the Diehn Center for the Performing Arts.

Proceeds from the Jaffe Professorship endowment funds will be used to provide a stipend of \$5,000 per year to Professor Toomey in the academic years 2018-2019 through 2022-2023.

Xiushi Yang

Professor, Department of Sociology and Criminal Justice

Dr. Yang's nomination package was recommended by the Promotion and Tenure Committee for the Department of Sociology and Criminal Justice, the Dean of the College of Arts and Letters, and endorsed by the University Named Chair Committee.

Dr. Yang's research focus is on migration in China and its effects on fertility, the spread of HIV/STIs and their prevention, and, more recently, synthetic drug abuse in China. He has an outstanding publication record with 2 co-edited books, 45 journal articles, including 17 as sole author and another 17 as first author, and 11 book chapters. Dr. Yang's work recorded 1,233 citations in Google Scholar, 570 citations in Web of Science, and 549 citations in Scopus. In addition to his scholarly publications, Dr. Yang has proven to be extremely successful in securing external grants with more than \$5 million in federal funding from the National Institute of Health (NIH). His respected expertise in his field of research has earned him multiple appointments as a grant peer reviewer for the National Science Foundation (NSF), NIH, and two international funding agencies, and a four-year appointment to the NIH Behavioral and Social Science Approaches to Preventing HIV/AIDS Study Section. In addition, he received the 2007 Burgess Award for Faculty Research Creativity and Productivity from the College of Arts and Letters.

Dr. Yang is regarded as a superb mentor and teacher who challenges his students at the graduate and undergraduate level. His portfolio reviews always meet or exceed expectations and student evaluations are always at or above 4.0 on a 5-point scale for student learning and teaching effectiveness.

Dr. Yang has contributed to the College by serving in several significant administrative roles. In addition to his ongoing service on departmental and promotion and tenure committees, he was the Chair of the Department of Sociology and Criminal Justice from 2013-2016, Director of the Social Science Research Center from 2009-2012, Graduate Program Co-Director for the M.A. in Applied Sociology Program from 1998-2000, and Director of the Arts and Letters Office of Research Services from 1994-1998.

Proceeds from the Jaffe Professorship endowment funds will be used to provide a stipend of \$5,000 per year to Dr. Yang in the academic years 2018-2019 through 2022-2023.

December 6, 2018

EMERITUS/EMERITA APPOINTMENTS

RESOLVED that, upon the recommendation of the Academic and Research Advancement Committee, the Board of Visitors approves the title of emeritus/emerita to the following faculty members and faculty administrators/faculty professionals. A summary of their accomplishments is included.

<u>Name and Rank</u>	<u>Effective Date</u>
Jimmie Carraway University Distinguished Teacher Emeritus and Senior Lecturer Emeritus of Information Technology and Decision Sciences	January 1, 2019
Valerian Derlega Professor Emeritus of Psychology	January 1, 2019
Michael J. Doviak Associate Professor Emeritus of Mathematics and Statistics	January 1, 2019
Sylvia Hudgins Professor Emerita of Finance	January 1, 2019
Karen Kott Associate Professor Emerita of Physical Therapy and Athletic Training	January 1, 2019
Edward P. Markowski University Professor Emeritus and Professor Emeritus of Information Technology and Decision Sciences	January 1, 2019
Kneeland Nesius University Professor Emeritus and Associate Professor Emeritus of Biological Sciences	January 1, 2019

JIMMIE CARRAWAY

Jimmie Carraway received a B.S.B.A. and M.B.A. from Old Dominion University. He joined Old Dominion as a full-time instructor in 1985, achieved the rank of senior lecturer in 1992, and was designated as a University Distinguished Teacher in 2015. Carraway designed and taught numerous undergraduate and graduate courses and successfully delivered positive learning outcomes to over 7,000 students during his academic career. He was instrumental in crafting the curriculum requirements utilized by the highly successful information systems and technology discipline. In addition, he has mentored and helped place hundreds of students in employment situations using his numerous professional contacts.

Carraway served 25 years as the discipline's Cooperative Education and Internship Coordinator and three years as the chair of the college's Information Technology Committee. In addition, he served five years as the Information Systems Laboratory Manager, a student resource he initially configured and designed as a service to the college. He also served multiple years as the original faculty sponsor for the Information Systems Project Management Professionals (ISPMP) student organization.

Recognition of his accomplishments in teaching and service include the college's Outstanding Advisor Award, the college's Outstanding Faculty Teaching Award (twice), the Most Inspiring Faculty Award (five separate occasions) as selected by his students, the Faculty Appreciation Award from the Office of Student Activities & Leadership, the Shining Star Award (five separate occasions) as selected by his students, and the Favorite Professor Award (twice) as selected by the Delta Sigma Lambda returning women's organization.

VALERIAN J. DERLEGA

Valerian J. Derlega, professor of psychology, received a Ph.D. from the University of Maryland and began his career in the Psychology Department in 1971. He has had a successful record of teaching, mentoring and supervising students, and service to the Psychology Department, the College of Sciences, and to Old Dominion University. In recognition of his research and teaching, he was the recipient of the Gene W. Hirschfeld Faculty Excellence Award and the Shining Star Award for Outstanding Teaching.

Derlega has had a distinguished career as a research psychologist. He has published 100+ scientific articles and 13 books, made 100+ presentations at scientific meetings, and received grant funding for his research from various private and public organizations (including the National Institute of Mental Health, the American Psychological Foundation and the National Institute on Drug Abuse). He is a Fellow of the American Psychological Association, the Society of Experimental Social Psychology, the Association for Psychological Science, and the Society for the Psychological Study of Social Issues.

Among his notable scholarly accomplishments, Derlega was a pioneer in theory and research on the role of self-disclosure and privacy regulation in personal relationships. He has contributed to research on psychological and social challenges confronting people living with HIV and sickle cell disease. More recently, he has maintained an active research program on the role of vicariously experienced violence (e.g., exposure to widely publicized mass shootings) on people's psychological reactions to these incidents and their willingness to engage in social action.

MICHAEL J. DOVIK

Michael J. Doviak, associate professor of mathematics and statistics, joined Old Dominion University in 1975. He earned a B.A. in mathematics from Alfred University, an M.A. in mathematics from Bucknell University, and an M.S. and Ph.D. in statistics from the University of Florida.

During his 40 plus years at Old Dominion University, Doviak conducted research in the areas of multivariate statistical methods and regression analysis. He has published seven articles in various professional journals. Doviak taught several different statistics courses at the undergraduate as well as the graduate level and was always ranked as one of the most popular instructors in the department. Throughout his career, his passion for teaching touched many students who chose their careers in the fields of mathematics and statistics.

SYLVIA HUDGINS

Sylvia C. Hudgins, professor of finance, joined Old Dominion University in 1989. She earned an M.B.A. from Old Dominion University and a Ph.D. from Virginia Tech. Hudgins has taught courses in banking, financial institutions, and corporate finance.

Hudgins examines questions concerning management, regulation, and legislation in her academic research. Much of her research focuses on the empirical analysis of commercial banks and thrifts. The journals publishing her research include: *Journal of Financial Economics*, *Journal of Money, Credit, and Banking*, *Financial Management*, and *Economic Inquiry*. She was co-author with Peter S. Rose on *Bank Management and Financial Services*—one of the top-selling bank management textbooks.

Professionally Hudgins has served as director of both the Eastern Finance Association and the Southern Finance Association and as a member of the Board of Editors for the Financial Management's Survey and Synthesis Series. Since the 1990's she has served as Treasurer and Board Member of the Old Dominion University Credit Union.

KAREN KOTT

Karen Kott earned a B.S. in physical therapy, an M.S. in exceptional children education, and a Ph.D. in learning and instruction-special education from the State University of New York at Buffalo. She has continuously maintained a license to practice physical therapy since completion of her baccalaureate degree.

Kott joined Old Dominion as an associate professor of physical therapy in 2006. She has been an active member of the teaching faculty, teaching classes both fall and spring semesters and mentoring approximately 15 doctoral students per year. She has been instrumental in developing Interprofessional Educational (IPE) experiences that are embedded in the doctor of physical therapy (DPT) curriculum in a way that helps students learn to work in teams with other healthcare professionals for best patient outcomes. This contribution will have a lasting impact on the curriculum.

Kott's interprofessional collaborations have resulted in dozens of publications and presentations in journals and forums that include dental health, nursing and home health care, physical therapy, and of course, interprofessional conferences. She has attended – with a presentation – all Annual Emsweiler Interprofessional Symposia over the last six years. Her activities, as part of an IPE team, have also been awarded hundreds of thousands of dollars in funding, including awards from Health Resources and Services Administration.

An exciting piece of Kott's IPE activities is the development of an Interprofessional Collaborative Clinic with DPT student involvement. The clinic is set up for individuals with little or no health care coverage. The focus is for students from physical therapy, medicine, dental hygiene, clinical counseling, social work and medical residents to work as a team with a client to develop a plan of care to help address the client's needs through resources in the community.

EDWARD P. MARKOWSKI

Edward P. Markowski received a Ph.D. in statistics from the Pennsylvania State University and joined Old Dominion as an assistant professor of mathematics and statistics in 1980. He joined the College of Business as an assistant professor of decision sciences in 1985, was promoted to associate professor in 1989 and to professor in 1995, and was designated as a University Professor in 2006. Markowski has twice been honored by the College of Business with the Outstanding Faculty Award in Teaching (1993 and 2005) and was named College of Business Outstanding Researcher in 1988. He has twice been designated for a three-year term as an E. V. Williams Teaching Fellow (2009-2011 and 2016- 2018). In 2009, he was selected as the recipient of the Alan Rufus Tonelson Distinguished Faculty award.

Markowski has been involved in nearly all aspects of teaching and curriculum development within the decision sciences discipline over the past 30+ years. He was one of the faculty who participated in the development of the Ph.D. program within the College of Business and has served on approximately 40 dissertation committees, primarily with students in business disciplines but also students from engineering, psychology, international studies,

and mathematical statistics. Markowski has been actively involved in scholarly work throughout his teaching career. He has published approximately 45 articles in leading academic journals in the fields of mathematical and applied statistics, decision sciences, operations and supply chain management, marketing, and strategic management. In addition, he has made a large number of research presentations at academic conferences.

Markowski has made significant contributions to the faculty governance of the university as both a member of important committees as well as leading such committees. He has been a member of the Faculty Senate and has chaired the Faculty Grievance Committee. He has also been a member and chair of Promotion and Tenure Committees at the departmental and college level. Outside the university, Markowski has been an active member of professional organizations, especially the American Statistical Association and the Decision Sciences Institute. Within the community, he has done statistical analysis for a number of private organizations.

KNEELAND NESIUS

After receiving a B.A. and M.S. in biological sciences from Purdue University, Kneeland Nesius completed a Ph.D. in botany and plant physiology at the University of Oklahoma before joining Old Dominion University as an assistant professor of biological sciences in 1973. He later attained the rank of associate professor.

During his tenure at ODU, Nesius taught a variety of courses including large sections of general biology and a more specialized course, plant physiology. His general botany course was popular and inspired students in plant science. Service to hundreds of students included serving as chief departmental advisor from 1988-2005. Nesius served on a dozen graduate student committees. His teaching prowess was recognized by receiving several Most Inspiring Teacher awards and by his appointment as University Professor in 2002.

Nesius's expertise with photosynthesis contributed to the Chesapeake Bay Program and other water quality research at ODU that involved productivity in diverse aquatic systems. This research was supported by grants and was published in a diversity of journals. In addition to botanical research papers and presentations, Nesius produced several laboratory manuals for general biology and also guides for land use planning for grades K through 12. His overall contributions to his scientific field and the university resulted in receiving the Gene Hirschfeld Faculty Excellence Award in 1996.

December 6, 2018

APPROVAL OF A BACHELOR OF SCIENCE DEGREE IN CYBERSECURITY

RESOLVED that, upon the recommendation of the Academic and Research Advancement Committee, the Board of Visitors approves the proposed Bachelor of Science degree in Cybersecurity in the College of Arts and Letters effective with the fall 2019 semester.

Rationale: Old Dominion University seeks approval to initiate a Bachelor of Science in Cybersecurity to begin fall 2019. The program would be administered by the Center for Cyber Security Education and Research (CCSER) and housed in the Department of Interdisciplinary Studies, College of Arts & Letters.

The degree program is designed to provide students with a strong understanding of cyber systems, threats, defense, and operation technologies. Graduates will be knowledgeable in the theory, technologies, skills, and practices necessary to protect critical cyber infrastructure and assets. They will have enhanced oral and written communication skills to articulate cybersecurity problems and decisions, and clearly understand ethical standards and rules.

The program responds to the vital needs for cybersecurity professionals in the Commonwealth of Virginia, the nation, and the world. Graduates will be prepared to work within the cybersecurity industry, U.S. Army, Navy, Air Force, and other branches of the military, and within federal, state, or local government or government contracting. Graduates will fill the demand for cybersecurity technical positions such as Cyber Intelligence Analyst, Cyber Security Analyst, Data Security Associate, Incident Response Analyst, Information Assurance Analyst, Information Security Analyst, Information Systems Security Officer, Security Consultant, Security Engineer, Security Specialist, Vulnerability Analyst, just to name a few.

The Bachelor of Science degree program in cybersecurity represents an expansion of the current cybersecurity major within the Bachelor of Science in Interdisciplinary Studies, which has been offered for the past three years. This expansion is needed to eliminate curricular restraints of a

major and to allow students to earn a degree that more closely matches the coursework they take and job opportunities they pursue after graduation. Further, a stand-alone degree program in cybersecurity will provide students with the degree—and degree name—that more accurately reflects the coursework taken. The focus on cybersecurity will advance students’ understanding of a broad range of cybersecurity topics in Virginia, in the United States, and internationally. Ultimately, the degree title will be more recognized for professionals employed in the field of cybersecurity, as opposed to a degree in interdisciplinary studies.

**STATE COUNCIL OF HIGHER EDUCATION FOR VIRGINIA
PROGRAM PROPOSAL COVER SHEET**

1. Institution Old Dominion University	2. Academic Program (Check one): New program proposal <input checked="" type="checkbox"/> Spin-off proposal <input type="checkbox"/> Certificate document <input type="checkbox"/>
3. Name/title of proposed program Cybersecurity	4. CIP code 11.1003
5. Degree/certificate designation Bachelor of Science	6. Term and year of initiation Fall 2019
7a. For a proposed spin-off, title and degree designation of existing degree program 7b. CIP code (existing program)	
8. Term and year of first graduates Fall 2019	9. Date approved by Board of Visitors
10. For community colleges: date approved by local board date approved by State Board for Community Colleges	
11. If collaborative or joint program, identify collaborating institution(s) and attach letter(s) of intent/support from corresponding chief academic officers(s)	
12. Location of program within institution (complete for every level, as appropriate and specify the unit from the choices). Departments(s) or division of <u>Department of Interdisciplinary Studies</u> School(s) or college(s) of <u>College of Arts & Letters</u> Campus(es) or off-campus site(s) <u>Main Campus in Norfolk</u>	
Mode(s) of delivery: face-to-face <input type="checkbox"/> hybrid (both face-to-face and distance) <input type="checkbox"/>	Distance (51% or more web-based) <input checked="" type="checkbox"/>
13. Name, title, and telephone number(s) of person(s) other than the institution's chief academic officer who may be contacted by or may be expected to contact Council staff regarding the modified program. Jeanie Kline, Ed.D. SCHEV Liaison, 757.683.3261.	

Description of the Proposed Program

Program Background

Old Dominion University (ODU) seeks approval to initiate a Bachelor of Science in Cybersecurity, scheduled to begin fall 2019 in Norfolk, Virginia. This proposed program will be administered by the Center for Cyber Security Education and Research (CCSER) and housed in the Department of Interdisciplinary Studies, College of Arts & Letters.

The proposed BS in Cybersecurity is designed to provide students with a strong understanding of cyber systems, threats, defense and operation technologies. Graduates will be knowledgeable in the theory, technologies, skills, and practices necessary to protect critical cyber infrastructure and assets. They will have enhanced oral and written communication skills to articulate cybersecurity problems and decisions, and clearly understand ethical standards and rules.

The program will prepare graduates to work within the cybersecurity industry, U.S. Army, Navy, Air Force, and other branches of the military, and within federal, state, or local government or government contracting. Graduates will fill the demand for cybersecurity technical positions such as Cyber Intelligence Analyst, Cyber Security Analyst, Data Security Associate, Incident Response Analyst, Information Assurance Analyst, Information Security Analyst, Information Systems Security Officer, Security Consultant, Security Engineer, Security Specialist, Vulnerability Analyst, just to name a few.

The proposed BS in Cybersecurity responds to the vital needs for cybersecurity professionals in the Commonwealth of Virginia, the nation, and the world. In recent years, cyberattacks have become more common, sophisticated, and harmful. In fact, no organization or individual with an online presence is immune to attacks, and the impact of cyberattacks can be devastating. Year 2017 is “a record year for stolen data”, according to digital security provider Gemalto,¹ which reports 1,765 data breaches in 2017 with a total of 2,600,968,280 compromised data records. The Gemalto report indicates that “One of the most significant developments of the year was an abundance of poor security practices. Malicious actors were able to hack Equifax in the summer of 2017, for example, because the credit bureau failed to improve its security practices after thieves made off with its data in May 2017 and earlier that year.” The Equifax data breach alone could affect 143 million people in the U.S., including 4 million in Virginia.² The Gemalto report also shows that “Incidents involving accidental loss increased significantly from under 250 million in 2016 to nearly 2 billion the following year” and “ransomware detections in 2017 were up 90 percent and 93 percent for businesses and consumers, respectively.”¹

¹ “Findings from the first half of 2017 Breach Level Index”, Page 3, Gemalto, <https://breachlevelindex.com/assets/Breach-Level-Index-Report-2017-Gemalto.pdf>

² Daily Press, <http://www.dailypress.com/news/dp-nws-virginia-equifax-breach-20170914-story.html>

As the volume and sophistication of cyberattacks grow, there is a strong demand for a well-trained cybersecurity workforce to address the multifaceted cybersecurity problems.³ This will require a solid education to develop skillsets that not only cover basic cybersecurity coursework but that will also provide students with multidisciplinary perspectives to examine security from a holistic view.

Executive Order Thirty-Nine from the Governor of Virginia states: “Cyber security instruction, training, and programs will be requisite components to prepare those currently seeking new occupational options as well as the next generation for the rapidly developing cyber security workplace. Focusing on cutting edge education and training will be essential for Virginia's cyber security workforce and economic development as occupations in the cyber security industry are highly in demand and among the fastest growing in the economy.”⁴ The proposed degree program will contribute to addressing such cybersecurity problems by preparing students to understand cybersecurity threats and develop more robust cyber defense systems. Graduates will become the next generation in the cybersecurity workforce to safeguard information relating to national security and various sensitive business and personnel data.

Mission

The mission of the institution states: “Old Dominion University, located in the City of Norfolk in the metropolitan Hampton Roads region of coastal Virginia, is a dynamic public research institution that serves its students and enriches the Commonwealth of Virginia, the nation and the world through rigorous academic programs, strategic partnerships, and active civic engagement.”

The proposed Bachelor of Science in Cybersecurity degree program aligns with this mission by (1) offering a “rigorous academic program” that trains individuals in the field of cybersecurity, (2) strengthening ODU’s “civic engagement” in its commitment to contributing to the economy and workforce of the Hampton Roads region and the Commonwealth of Virginia, and (3) enhancing the “strategic partnerships” in cybersecurity that ODU has developed throughout the region.

Online Delivery

The upper-level coursework in the proposed BS in Cybersecurity degree program will be offered primarily in online settings, with several upper-level classes available on campus as well. Lower-level general education and cybersecurity classes may be completed in online and on-campus settings. Within both formats, students will be able to access course materials through Blackboard, the University’s course management system. All assignment submissions and other

³ “Multifaceted security: preparing your cyber offense”, Page 2, [http://www.ey.com/Publication/vwLUAssets/EY-top-of-mind-four-themes-multifaceted-security/\\$FILE/EY-top-of-mind-four-themes-multifaceted-security.pdf](http://www.ey.com/Publication/vwLUAssets/EY-top-of-mind-four-themes-multifaceted-security/$FILE/EY-top-of-mind-four-themes-multifaceted-security.pdf)

⁴ “Commonwealth of Virginia Office of the Governor Executive Order Number Thirty Nine”, Page 2, <https://vdocuments.mx/commonwealth-of-virginia-office-of-the-governor-executive-of-virginia-office.html>.

course management actions will take place in Blackboard. Further, faculty-student interaction is available via email, phone, in-person meetings, and WebEx-interface meetings.

Faculty members who teach in the web-based format are trained in course development and delivery through the Center for Learning and Teaching (CLT). There, instructional designers and technologists work individually with each faculty member to convert course content, assignments, testing, and other course work to a web-based platform. Faculty work closely with the designers to ensure web-based content is the same as content taught in face-to-face settings.

Beyond the usual online offerings at ODU, cybersecurity is a field that requires extensive hands-on experience, which has been shown to be an important factor in stimulating students' interest and sharpening their scientific reasoning and problem-solving skills. To this end, ODU has made significant investments in the creation of a state-of-the-art cybersecurity infrastructure, including a cybersecurity lab consisting of 24 dedicated workstations, a Nutanix hyper-converged system that supports virtual machines, two Cisco lab switches, a Cisco N3k-3172-T data center grade switch, and a Palo Alto 850 NGFW firewall. Online students can remotely connect to the lab facility to conduct various real-world cybersecurity experiments.

Admission Criteria

The requirements for admission to the proposed Bachelor of Science in Cybersecurity will include:

- An online admission application and associated application fee
- For freshmen: official transcripts from secondary institution(s) and/or General Education Development (GED) work
- For transfer students: official transcripts from all regionally-accredited post-secondary institutions or equivalent foreign institutions attended, with a minimum GPA of 2.5 in prior coursework; a GPA of 3.0 or better will make the applicant more competitive

Non-native English speakers are required to provide official scores of 550 on the paper-based, or 79-80 on the iBT, Test of English as a Foreign Language (TOEFL).

Other factors such as co/extra-curricular activities, community service, personal statements, recommendations, and special talents and leadership may also be considered.

Target Population

The proposed bachelor's program will target students who are enrolled in cybersecurity associate degrees where ODU has developed articulation agreements. These include the following colleges:

- Tidewater Communication College
- Thomas Nelson Community College
- Northern Virginia Community College

The articulations facilitate the seamless transfer of community college graduates to ODU. The students who graduate under the articulations are guaranteed admission to ODU’s cybersecurity program, which is the most affordable doctoral research institution in the state.

Curriculum

The proposed Bachelor of Science in Cybersecurity is a 120-credit hour degree program focused on understanding cybersecurity fundamentals, applications, and operations, while providing opportunities for students to integrate education and training with the usage of problem-solving skills in the lab environment.

The curriculum of the proposed BS in Cybersecurity includes a cybersecurity core that introduces fundamental concepts associated with the field of cybersecurity. The faculty also developed an interdisciplinary core that allows for students to gain an understanding of theory and practice related to combining disciplines in academic and professional areas. In addition, faculty included a law/ethics component that provides essential details about ethical and/or legal aspects of cybersecurity. The cybersecurity foundations area consists of key concepts related to threats and vulnerabilities, infrastructures, cryptography, and other facets of cybersecurity that students will need in the field. Finally, the curriculum includes opportunities for students to apply their knowledge of cybersecurity in hands-on applications with digital forensics, networks, enterprises, and others.

Ultimately, the proposed program will establish a solid educational foundation and prepare students for jobs in cybersecurity with the theory, technologies, skills, and practices necessary to safeguard critical cyber infrastructure and protect confidential information against unauthorized access, unauthorized use, loss, or damage.

Program Requirements

Lower-Division General Education (35-44 credit hours):

- Written Communication 6
- Oral Communication 3
- Mathematics (MATH 162M required) 3
- Language and Culture 0-6
(may be met prior to matriculation)
- Information Literacy and Research 3
- Human Creativity 3
- Interpreting the Past 3
- Literature 3
- Philosophy and Ethics (can be met by PHIL 355E) 0-3
- The Nature of Science 8
- Impact of Technology (CYSE 200T required) 0
- Human Behavior 3

Cybersecurity Core Courses (21 credit hours):

- CYSE 200T Cybersecurity, Technology, and Society 3

- CYSE 250 Basic Cybersecurity Programming and Networking 3
- CYSE 300 Introduction to Cybersecurity 3
- CYSE 301 Cybersecurity Techniques and Operations 3
- CYSE/CRJS/CPS 406 Cyber Law 3
- CYSE 425W Cybersecurity Strategy & Policy 3
- CS 462 Cybersecurity Fundamentals
 - or CS 455 Introductions to Networks and Communications
 - or ECE 455 Network Engineering and Design 3

Interdisciplinary Studies Core (9 credit hours):

- IDS 300W Interdisciplinary Theory and Concepts 3
- CYSE 368 Cybersecurity Internship
 - or CYSE 494 Entrepreneurship in Cybersecurity 3
- IDS 493 IDS Electronic Portfolio Project 3

Cybersecurity Foundations (9 credit hours)

Select three from the following:

- CRJS 405 Cybercrime and Cybersecurity 3
- CS 462 Cybersecurity Fundamentals*
 - or ECE/MSIM 470 Foundations of Cyber Security 3
- CS 463 Cryptography for Cybersecurity 3
- CS 464 Networked Systems Security
 - or ECE/MSIM 411 Networked System Security 3
- CS 465 Information Assurance (3)
- CYSE/POLS 495 Topics (Cybersecurity and Policy) 3
- ECE/MSIM 416 Cyber Defense Fundamentals 3
- ECE/MSIM 419 Cyber Physical System Security 3
- ECE/MSIM 470 Foundations of Cyber Security 3
- IT 315 Introduction to Networking and Security 3
- IT 417 Management of Information Security 3
- PHIL 355E Cybersecurity Ethics 3

Cybersecurity Applications (9 credit hours)

Select three from the following:

- CS 495 Topics (Software Reverse Engineering) 3
- CYSE 407/CRJS 395 Digital Forensics 3
- CYSE/POLS 495 Topics (Cyberwar) 3
- ECE/MSIM 417 Secure and Trusted Operating Systems 3
- ECE 452 Introduction to Wireless Communication Networks 3
- ECE 455 Network Engineering and Design* 3
- IT 410 Business Intelligence 3
- IT 416 Network Server Configuration and Administration 3
- IT 418 Information Assurance 3
- IT 419 Enterprise Cyber Defense 3
- IT 461 Implementing Internet Applications 3

*Courses can count in Applications or Foundations only if they were not taken as part of the core.

Prerequisites and/or Electives

25-34 credit hours, as needed to complete the required 120 credit hours

Appendix A provides sample plans of study for full- and part-time students. Course descriptions may be found in Appendix B.

Student Retention and Continuation Plan

Pre-emptive approaches will be adopted to ensure students succeed in the proposed program. Specific plans for student retention and continuation include:

- Requiring an online orientation session for all new students, aimed at introducing the program, curriculum, requirements, expectations, faculty, facility, and other relevant resources that are online or remotely accessible through the myODU portal;
- Providing an up-to-date curriculum and a long-range course schedule to help students plan their enrollment and time to completion;
- Requiring a minimum of one advising session per semester (online or face-to-face) and providing personalized advising throughout students' program of study;
- Holding special advising sessions for transfer students; and
- Encouraging students to join ODU's Cybersecurity Student Association, which hosts regular meetings for students to share success stories, talk about strategies to complete the program and discuss future career pathways. This is a means of building a community of cybersecurity learners who can support each other throughout the program.

When individual student performance demonstrates a lack of success, faculty will explore ways to encourage success. These include:

- Individualized advising and mentoring to help the student pass course(s);
- Connecting to a successful local cybersecurity professional to motivate the student to understand the importance of cybersecurity, appreciate the work of cybersecurity professionals, and develop a pride to become cybersecurity professionals;
- Involvement in state-of-the-art cybersecurity projects to stimulate student's interest to become motivated and excited to study cybersecurity and learn beyond classroom instruction; and
- Creating a cohort to increase interactions and peer learning.

Time to Degree

Full-time students will be able to complete the proposed BS in Cybersecurity in four calendar years. Part-time students can complete the program in six to eight calendar years, depending on

their course load each semester. Courses are also offered in summer terms for students to complete in an accelerated pace, if desired.

Faculty

Seven faculty members affiliated with the Center for Cyber Security Education and Research (CCSER) will teach in the proposed Bachelor of Science in Cybersecurity degree program. Three faculty members are tenured: two professors and one associate professor. Four faculty members are lecturers. The seven faculty represent several colleges at the university: College of Arts and Letters), Strome College of Business, Batten College of Engineering and Technology), and College of Sciences. They will teach core, foundation, law/ethics, and application coursework.

The faculty have breadth and depth in areas of cybersecurity, ranging from software to hardware security and from fundamental cybersecurity technologies to human factors in cybersecurity. Combined, they have over 100 years of postsecondary teaching experience, an extensive record of scholarship with over 90 recent publications in peer-reviewed journals and conferences in cybersecurity fields. They currently have approximately 10 active research grants from prestigious organizations such as the National Science Foundation.

Abbreviated CVs for existing full-time faculty members can be found in Appendix C.

Program Administration

This proposed Bachelor of Science in Cybersecurity degree program will be housed in the Department of Interdisciplinary Studies, College of Arts & Letters, and administered by the Center for Cyber Security Education and Research (CCSER). CCSER was established to weave together distinct threads of programmatic and facility resources to create a strong education and research program focusing on cybersecurity. It represents an interdisciplinary effort related to faculty, degree programs, certificates, and research initiatives from four colleges, eight academic departments, the Office of Research, Information Technology Services, and the Virginia Modeling, Analysis and Simulation Center. It consists of approximately 30 affiliated faculty and staff from across Old Dominion University.

A CCSER faculty will be appointed as the program coordinator. She or he will assume responsibility for setting class schedules, advising students, coordinating student meetings and activities, gathering student input, handling students' concerns, collecting admission and enrollment information, and meeting with the faculty, the CCSER director, and dean or associate dean of the College of Arts and Letters to discuss programmatic matters.

The administrative assistant in CCSER will support faculty and students in this program; approximately 20% of this individual's time will be devoted to the proposed program. The assistant will help with the processing of applications, scheduling of courses, handling registration issues, updating the catalog, and website management.

Student Assessment

Students will be evaluated throughout the program using formative assessments, such as quizzes, tests, cases studies, papers, research projects, and presentations. Student learning outcomes cover many of the technical competencies that are required for the area of cybersecurity. Specifically, graduates will be able to:

1. Analyze ethical and social issues in the area of cybersecurity to clearly understand ethical standards and rules for cybersecurity professionals and to promote social responsibility;
2. Communicate in writing their understanding of cybersecurity problems and decisions about cyber defense and operations in a cohesive and well-structured manner;
3. Integrate principles and methods from a variety of disciplines to develop and implement best practices to solve cybersecurity complexities;
4. Analyze global cybersecurity problems and make decisions that enhance the effectiveness of cyber defense and operation solutions based on these analyses; and
5. Orally communicate their understanding of cybersecurity, and explain decisions in cohesive and well-structured presentations to both technical and non-technical audience.

These student learning outcomes are provided in the following assessment map.

Curriculum Map of Cybersecurity Program Core Courses

Learning Outcomes	Courses	Assessment Methods
<p>1. Ethics Analyze ethical and social issues in the area of cybersecurity to clearly understand ethical standards and rules for cybersecurity professionals and to promote social responsibility.</p>	<p>CYSE 200T Cybersecurity, Technology, and Society</p>	<p><u>Formative:</u> Group reading and book review; critical thinking and analysis assignments.</p> <p><u>Summative:</u> Midterm and final exams assessing knowledge of the ethical standards and rules for cybersecurity professionals.</p>
<p>2. Written Communication Communicate in writing their understanding of cybersecurity problems and decisions about cyber defense and operations in a cohesive and well-structured manner.</p>	<p>CYSE 200T Cybersecurity, Technology, and Society</p> <p>IDS 300W Interdisciplinary Theory and Concepts</p>	<p><u>Formative:</u> Group reading and discussion; written assignments; short essays; and digital portfolio.</p> <p><u>Summative:</u> Midterm and final exams assessing critical thinking and written communication skills.</p>

	<p>CYSE 425W Cybersecurity Strategy & Policy</p> <p>CYSE/CRJS/CPS 406 Cyber Law</p> <p>IDS 493 IDS Electronic Portfolio Project</p>	
<p>3. Analytical Problem Solving Integrate principles and methods from a variety of disciplines to develop and implement best practices to solve cybersecurity complexities.</p>	<p>CYSE 250 Basic Cybersecurity Programming and Networking</p> <p>CYSE 300 Introduction to Cybersecurity</p> <p>CYSE 301 Cybersecurity Techniques and Operations</p> <p>CYSE/CRJS/CPS 406 Cyber Law</p> <p>CS 471 Operating Systems</p>	<p><u>Formative:</u> Real-world application scenarios; case analysis; critical thinking and analysis assignments.</p> <p><u>Summative:</u> Midterm and final exams assessing knowledge of the cyber system risks and vulnerabilities and diagnosis principles and methods.</p>
<p>4. Global Perspective Analyze global cybersecurity problems and make decisions that enhance the effectiveness of cyber defense and operation solutions based on these analyses.</p>	<p>CYSE 200T Cybersecurity, Technology, and Society</p> <p>CYSE 250 Basic Cybersecurity Programming and Networking</p>	<p><u>Formative:</u> Real-world application scenarios; case study of the global impact of a cyberattack; critical thinking and analysis assignments.</p> <p><u>Summative:</u> Midterm and final exams assessing knowledge of the international cybersecurity threats in the Internet.</p>
<p>5. Oral Communication Orally communicate their understanding of cybersecurity, and explain decisions in cohesive and well-structured</p>	<p>CYSE 250 Basic Cybersecurity Programming and Networking</p>	<p><u>Formative:</u> Design assignments; oral presentation of a cyber defense plan for a campus network.</p> <p><u>Summative:</u></p>

presentations to both technical and non-technical audience.		Midterm and final exams assessing knowledge of technical communication principles and practice.
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Employment Skills/Workplace Competencies

Graduates of the proposed BS in Cybersecurity degree program will have the skills and abilities needed for employment and workplace competencies in the field of cybersecurity. Specifically, they will have the ability to:

1. apply leading-edge principles, theories, and concepts to the development of information security standards, procedures, and guidelines;
2. plan, design, implement and operate security-related technologies;
3. perform vulnerability analyses and assessment and develop plans for vulnerability mitigation;
4. troubleshoot and/or provide technical support in the cybersecurity event;
5. participate in network and systems design to ensure implementation of appropriate systems security policies;
6. identify and specify information systems security requirements associated with migrations to new environments;
7. communicate the value of cyber security throughout all levels of the organization's stakeholders.

Program Assessment

The program will be assessed by faculty and administrators in the Center for Cyber Security Education and Research, the Department of Interdisciplinary Studies, the College of Arts & Letters, and the provost's office. The review will be completed annually in the fall starting from the second year after the program is approved, and will consist of:

- Analyzing retention and attrition rates in order to maximize the positive influences and improve the negative ones that affect program completion
- Analyzing the results of the Old Dominion University Student Satisfaction Survey for areas where additional student support is needed
- Analyzing graduate job placement to assess if the program is preparing students with the knowledge, skills and abilities for jobs in cybersecurity, and evaluate the program's ability to meet market demands (following initial graduates' completion)

Results of these assessments will be used to evaluate the quality of the program, to stimulate program development, and to assess the role of the program in fulfilling Old Dominion University's institutional mission. The program review may (a) result in strategic decisions about the program, (b) identify areas of improvement, (c) make resource recommendations, (d) articulate considerations for expansion or consolidation, and/or (e) consider other aspects of programmatic quality with respect to policies and practices relative to:

- Student recruitment, admissions, advising, and retention;
- Enrollment projections including consideration of the context of the SCHEV 5-year benchmark and other on-going enrollment targets;
- Course descriptions and implementation;

- Approved curricular changes and development;
- Faculty development and research activities;
- Facilities;
- Internal and external funding; and
- Description of strengths and weaknesses with attention to action items for the future.

The dean and associate dean in the College of Arts & Letters will read the program review each year to ensure that benchmarks are met and excellence is maintained. The College's annual evaluation of the program will be sent each year to the vice provost of academic affairs for review. The vice provost will offer guidance, as needed, for improvement, and will provide updates about the review to the provost.

Benchmarks of Success

Benchmarks of success for the BS in Cybersecurity include the following student enrollment and graduate goals:

- Approximately 75 new students will be admitted each year
- The program will graduate a minimum of 45 students annually by the completion of the program's target year
- 60% of the students who begin the program will successfully complete the program within five years of matriculation
- 80% of graduates will be employed in cybersecurity positions using knowledge acquired in their undergraduate studies within six months of completion
- 80% of students will be satisfied with the program as determined by the university's Student Satisfaction Survey
- 80% of alumni will be satisfied with the program as determined by the university's Alumni Survey, administered within one year of completion
- 80% of employers will be satisfied with the level of education and skill of graduates, as measured by an employer survey administered within one year of hire.

After the first year and subsequent years, periodic evaluations of the success of the program in meeting these benchmarks will be undertaken. If program benchmarks are not achieved, the program coordinator and the program faculty will examine the program's admissions policies, curriculum, instructional methods, advising practices, and course evaluations to determine where changes need to be made.

Expansion of an Existing Program

The proposed degree program represents an expansion of the current cybersecurity major within the Bachelor of Science in Interdisciplinary Studies, which has been offered for the past 3 years. This expansion is needed to eliminate curricular restraints of a major and to allow students to earn a degree that more closely matches the coursework they take and job opportunities they pursue after graduation.

The curriculum required for the cybersecurity degree program is not the curriculum required for the cybersecurity major in interdisciplinary studies. The focus on the need for trained cybersecurity professionals has heightened since the major started, and it has become its own disciplinary area. The faculty has determined that cybersecurity needs a separate curriculum in order to provide the didactic and application coursework needed to fully educate students in the area of cybersecurity.

Further, a stand-alone degree program in cybersecurity will provide students with the degree—and degree name—that more accurately reflects the coursework taken. The focus on cybersecurity will advance students' understanding of a broad range of cybersecurity topics in Virginia, in the United States, and internationally. Ultimately, the degree title will be more recognized for professionals employed in the field of cybersecurity, as opposed to a degree in interdisciplinary studies.

If the proposed BS in Cybersecurity is approved, the cybersecurity major in the BS in Interdisciplinary Studies will be discontinued.

Relationship to Existing ODU Degree Programs

The proposed BS in Cybersecurity is not similar or related to any other existing degree program at ODU.

Compromising Existing Programs

No degree programs will be compromised or closed as a result of the initiation and operation of the proposed degree program.

Collaboration or Standalone

This is a standalone program. No other organization was involved in its development, and no other organization will collaborate in its operation.

Justification for the Proposed Program

Response to Current Needs (Specific Demand)

Cybersecurity is a rapidly-growing field that is expected to generate a significant number of new jobs over the next decade, as both government and industry make substantial investments to protect their cyber space.

With the increasing reliance on computer systems and networks, more pervasive, sophisticated, and destructive cyberattacks are occurring with greater frequency. In fact, no organization or individual anywhere in the world is completely immune to cyberattacks.

Impact of Cyber Attacks on National Security, Private Sectors, and Society

Former national intelligence director, James Clapper, noted that cyberattacks rank highest on worldwide threats to U.S. national security.⁵ According to Department of Homeland Security, “The federal enterprise depends on information technology (IT) systems and computer networks for essential operations. These systems face large and diverse cyber threats that range from unsophisticated hackers to technically competent intruders using state-of-the-art intrusion techniques. Many malicious attacks are designed to steal information and disrupt, deny access to, degrade, or destroy critical information systems.”⁶ The proposed program will prepare students to help IT professionals in the federal and state government enterprise to understand cyber risks and vulnerabilities and design stronger and more robust defense systems against cyberattacks.

IBM Corporation’s Chairman, CEO and President, Ginni Rometty, said that cybercrime may be the greatest threat to every company in the world.⁷ According to an analysis conducted by Cybersecurity Ventures, the global annual cybercrime costs have been estimated at \$3 trillion in 2015, and it could reach \$6 trillion by 2021.⁸ Global spending on cybersecurity products and services for defending against cybercrime is projected to exceed \$1 trillion cumulatively over the next five years, from 2017 to 2021, according to the Cybersecurity Market Report, which is published quarterly by Cybersecurity Ventures.⁹ In response to these efforts, the proposed program provides advanced education in leadership in the field of cybersecurity, thus enhancing their skills and competencies that address cybersecurity-related matters.

Cyberattacks not only impact national security and the economy, but they also affect individuals personally in their daily lives. For example, in July 2015, hackers stole social security numbers, health records, and other highly sensitive data from 21 million Americans through the Office of Personnel Management in what, at the time, was the largest data breach in U.S. history. In 2017, malware WannaCry affected more than 230,000 users in some 150 countries.¹⁰ The proposed program will prepare students with oral and written communication skills to help people understand such cyberattacks and learn how to mitigate their impacts.

⁵ “James Clapper, intel chief: Cyber ranks highest on worldwide threats to U.S.”, <http://www.washingtontimes.com/news/2015/feb/26/james-clapper-intel-chief-cyber-ranks-highest-worl/>

⁶ “Securing Federal Networks”, <https://www.dhs.gov/topic/securing-federal-networks>

⁷ “Cyber Crime Costs Projected to Reach \$2 Trillion by 2019”, <https://www.forbes.com/sites/stevemorgan/2016/01/17/cyber-crime-costs-projected-to-reach-2-trillion-by-2019/#5f8e8fcb3a91>

⁸ “Cybercrime Report”, <http://cybersecurityventures.com/hackerpocalypse-cybercrime-report-2016/>

⁹ “2016 U.S. Government Cybersecurity Report”, Page 2, https://cdn2.hubspot.net/hubfs/533449/SecurityScorecard_2016_Govt_Cybersecurity_Report.pdf

¹⁰ “How the WannaCry Attack Will Impact Cyber Security”, May 2017, <http://knowledge.wharton.upenn.edu/article/massive-global-cyberattack/>

Shortage of Cybersecurity Talent

As the volume and sophistication of cyberattacks grow, there is a strong demand for well-trained cybersecurity workforce to safeguard the cyber space. Dr. Ronald Dodge from the United States Military Academy and Drs. Costis Torgas and Lance Hoffman from The George Washington University noted that “the cybersecurity workforce is one of the most critical employment sectors in the world.”¹¹

However, recent studies have shown that there is a serious shortage of talent to fill cybersecurity positions. According to a study conducted by Information Systems Audit and Control Association (ISACA), a global leader in cybersecurity, “82 percent of organizations expect to be attacked, but they are relying on a talent pool they view as largely unqualified and unable to handle complex threats or understand their business. More than one in three (35 percent) are unable to fill open positions.”¹² According to International Information System Security Certification Consortium’s, or (ISC)²’s, Global Information Security Workforce Study (GISWS), which queried 19,000 cybersecurity professionals worldwide, “The data clearly demonstrate much work is yet to be done to secure businesses, government agencies and organizations of all sizes, and the critical importance of having a properly staffed, agile and reactive workforce. However, in the 2015 edition of the GISWS, 62% of information security workers reported having too few workers to address the threats they encountered. In 2017, that number has ticked higher, with 66% indicating that they do not have the staff necessary to address the threats, indicating that the shortage of information security workers is widening, as more sectors recognize the importance of deploying a skilled cyber workforce to protect their data.”¹³

Based on a global survey of 461 cybersecurity managers and practitioners,¹⁴ 75 percent of respondents expect to fall prey to a cyberattack in 2016. “82 percent of respondents report that their enterprise board of directors is ‘concerned’ or ‘very concerned’ about cybersecurity.” “Although enterprises continue to increase spending and effort on cybersecurity, respondents indicate that they struggle to fill positions with highly skilled workers—60 percent of all respondents do not believe their information security staff can handle anything more than simple cybersecurity incidents.”¹⁴ According to Enterprise Strategy Group (ESG)’s annual IT spending intentions research based on 600 IT and cybersecurity professionals, “cybersecurity has been identified as the number one problematic shortage area across all of IT for the past six years in a row.” In 2017, “45% of organizations say they have a problematic shortage of cybersecurity

¹¹ Ronald C Dodge, Costis Torgas and, Lance Hoffman, “Cybersecurity Workforce Development Directions”, in Proceedings of The Sixth International Symposium on Human Aspects of Information Security & Assurance, 2012.

¹² “State of Cybersecurity: Implications for 2015”, An ISACA and RSA Conference Survey, <http://www.isaca.org/About-ISACA/Press-room/News-Releases/2015/Pages/Study-82-percent-of-Organizations-Expect-a-Cyberattack-Yet-35-percent-Are-Unable-to-Fill-Open-Security-Jobs.aspx>

¹³ “2017 Global Information Security Workforce Study”, Page 3, <https://iamcybersafe.org/wp-content/uploads/2017/06/Europe-GISWS-Report.pdf>

¹⁴ “State of Cybersecurity: Implications for 2016”, https://www.isaca.org/cyber/Documents/state-of-cybersecurity_res_eng_0316.pdf

skills.”¹⁵ The proposed program is aimed at filling the gap. Students will be educated to develop skills and competencies in technical aspects of cyber security.

Demand for Bachelor’s Degree Program in Cybersecurity

In the article by Dan Restuccia about “How to Get a Cybersecurity Job in Three Charts”, the first step is to get a bachelor’s degree. The article cites that “more than eight in 10 (83%) of job postings for cybersecurity workers ask for a bachelor’s degree or higher. That means ‘quick fix’ training programs won’t necessarily close the talent gap, or allow a jobseeker to compete.”¹⁶

The expectations are that the demand for a bachelor’s degree is likely to increase further, considering that computer systems and software are becoming more and more pervasive. A look at one way the government has tried to build and recruit such talent—offering university scholarships—shows why.¹⁷ For example, NSF’s CyberCorps Scholarship for Service (SFS) program “provides funding to award scholarships to students in cybersecurity.”¹⁸ It “provides academic-year stipends of \$22,500 per year for undergraduate students.”¹⁸ After school, recipients serve in government for the same length of time as they received funding, typically two to three years.

The demand for bachelor level education is also evidenced by the National Security Agency (NSA) Centers of Academic Excellence (CAE) designations. For example, the “CAE Cyber Operations program is intended to be a deeply technical, inter-disciplinary, higher education program firmly grounded in the computer science (CS), computer engineering (CE), and/or electrical engineering (EE) disciplines, with extensive opportunities for hands-on applications via labs/exercises.”¹⁹ (The proposed program offers such an interdisciplinary focus.) Fourteen out of the 20 NSA CAE centers are BS programs.¹⁹ Thus, a bachelor’s degree in cybersecurity is a credential that is—and will continue to be—desired by professionals in the field.

Employment Demand

National/International Focus

According to a recent study of cybersecurity professionals, “more than one-third (34%) have less than 3 years’ experience while 30% have been cybersecurity professionals for at least 15 years.”²⁰ The cybersecurity unemployment rate was 0% in 2016, and it is expected to remain

¹⁵ “Cybersecurity skills shortage holding steady”,

<http://www.csoonline.com/article/3177374/security/cybersecurity-skills-shortage-holding-steady.html>

¹⁶ “How to Get a Cybersecurity Job in Three Charts: a Degree, a Certification, and a Clearance”, Dan Restuccia, Labor Market Analysis, Research, May 13, 2016, <https://www.burning-glass.com/blog/how-to-get-a-cybersecurity-job-in-three-charts-a-degree-a-certification-and-a-clearance/>

¹⁷ “The U.S. Government Wants 6,000 New ‘Cyberwarriors’ by 2016”, by Dune Lawrence, available online at <https://www.bloomberg.com/news/articles/2014-04-15/the-u-dot-s-dot-government-wants-6-000-new-cyberwarriors-by-2016>

¹⁸ NSF Program Solicitation 17-556. <https://www.nsf.gov/pubs/2017/nsf17556/nsf17556.htm>

¹⁹ National Centers of Academic Excellence in Cyber Operations, <https://www.nsa.gov/resources/educators/centers-academic-excellence/cyber-operations/centers.shtml>

²⁰ “The Life and Times of Cybersecurity Professionals”, Page 9, Nov., 2017.

<https://c.ymdn.com/sites/www.issa.org/resource/resmgr/surveyeyes/ESG-ISSA-Research-Report-Lif.pdf>

there from 2017 to 2021.²¹ U.S. News and World Report ranked a career in information security analysis seventh on its list of the 10 best technology jobs for 2017.²² Further, “the field of cybersecurity is the least populated of any field of technology,” according to John McAfee, founder of McAfee, Inc. “There are two job openings for every qualified candidate.”²³

According to the Bureau of Labor Statistics, the rate of growth for jobs in information security is projected at 28% from 2016–2026, “much faster than the average.”²⁴

In addition, the high demand for cybersecurity talent has been reported by multiple sources:

- In 2017, the U.S. employed nearly 780,000 people in cybersecurity positions, with approximately 350,000 current cybersecurity openings, according to CyberSeek, a project supported by the National Initiative for Cybersecurity Education (NICE), a program of the National Institute of Standards and Technology (NIST) in the U.S. Department of Commerce.²⁵
- Burning Glass Technologies, an analytics software company powered by the world’s largest and most sophisticated database of labor market data, reports that cybersecurity openings are growing three times faster than overall IT postings.²⁶
- Cybersecurity Ventures predicts there will be 3.5 million unfilled cybersecurity positions globally by 2021.²⁵
- Michael Brown, CEO at Symantec, the world’s largest security software vendor, estimates that the demand for cybersecurity professionals will reach 6 million globally by 2019.²⁷
- The ISACA, a non-profit information security advocacy group, predicts there will be a global shortage of two million cyber security professionals by 2019.²⁸

²¹ “Zero-percent cybersecurity unemployment, 1 million jobs unfilled”

<https://www.csoonline.com/article/3120998/techology-business/zero-percent-cybersecurity-unemployment-1-million-jobs-unfilled.html>

²² “Best Technology Jobs,” U.S. News, <https://money.usnews.com/careers/best-jobs/rankings/best-technology-jobs>

²³ “Cybersecurity job market to suffer severe workforce shortage”

<http://www.csoonline.com/article/3201974/it-careers/cybersecurity-job-market-statistics.html>

²⁴ <https://www.bls.gov/ooh/computer-and-information-technology/information-security-analysts.htm>

²⁵ “Cybersecurity labor crunch to hit 3.5 million unfilled jobs by 2021”

<https://www.csoonline.com/article/3200024/security/cybersecurity-labor-crunch-to-hit-35-million-unfilled-jobs-by-2021.html>

²⁶ “Job Market Intelligence: Cybersecurity Jobs, 2015,” Page 3

http://burning-glass.com/wp-content/uploads/Cybersecurity_Jobs_Report_2015.pdf

²⁷ “Cybersecurity job market to suffer severe workforce shortage”

<http://www.csoonline.com/article/2953258/it-careers/cybersecurity-job-market-figures-2015-to-2019-indicate-severe-workforce-shortage.html>

²⁸ “The Fast-Growing Job With A Huge Skills Gap: Cyber Security”,

<https://www.forbes.com/sites/jeffkaufman/2017/03/16/the-fast-growing-job-with-a-huge-skills-gap-cyber-security/#65b9059a5163>

Virginia Focus

There are over 30,000 cybersecurity job openings in Virginia – one of the highest among all states.²⁹ “At a time when Virginia is home to 36,000 open jobs in the cybersecurity sector, we must do everything we can to encourage students to enter this growing industry,” said Governor Terry McAuliffe at an event to announce the recipients of the Commonwealth’s first Cybersecurity Public Service Scholarship. “Our problem in Virginia, unlike other states, is we have too many open jobs, high-paying jobs we cannot fill in Virginia today. Standing here today I have 36,000 cyber jobs open. I tell (students) the starting pay is \$88,000,” McAuliffe said in another event, “We either fill these jobs or they go to other states.”³⁰

In May 2015 over 7,500 job openings for cyber-security related occupations were advertised through the Virginia Employment Commission (VEC). The number of persons employed in this occupational group in the Commonwealth is expected to increase by 41.51% from 2016 through 2026 (3.53% Annual Average % Change).³¹ The VEC indicated that jobs in this field, such as Information Security Analysts, are abundant.³² As of July 31, 2018, there were 1,365 openings for Information Security Analysts and 0.21 candidates available per job opening.

A report by Burning Glass Technologies showed that 61% of cyber security postings require at least a bachelor’s degree.³³ Given a total of 350,000 cybersecurity openings in the U.S. and 33,000 in Virginia, it is estimated that over 213,500 in the US and 20,130 positions in Virginia require at least a bachelor’s degree.

Given the high demand for this cybersecurity workforce and the serious shortage of cybersecurity talent, the proposed program is aimed at filling the gap. While it may be possible to find entry-level cyber security positions with an associate’s degree, most jobs require a four-year bachelor’s degree in cyber security or a related field such as information technology or computer science. Coursework in cyber technologies with classes in ethics and computer forensics prepare students with the technical and analytical skills required for successful careers in cyber security.

Job announcements are included in Appendix D.

Student Demand

Student demand for a bachelor’s degree in cybersecurity is strong, as evidenced by two sets of data, as follows.

1. Enrollments in the current Bachelor of Science in Interdisciplinary Studies with a major

²⁹ <http://cyberseek.org/heatmap.html>

³⁰ “36,000 unfilled Va. jobs have \$88,000 starting pay, governor says”, <http://wtvr.com/2017/07/24/virginia-computer-jobs/>

³¹ <https://data.virginialmi.com/vosnet/analyzer/results.aspx?session=occproj>

³² The Official Site of The Commonwealth of Virginia, <https://data.virginialmi.com>.

³³ “Job Market Intelligence: Cybersecurity Jobs”, Page 6, http://burning-glass.com/wp-content/uploads/Cybersecurity_Jobs_Report_2015.pdf

in cybersecurity has gained tremendous growth in enrollment since it was launched in 2015. Specifically, the Office of Institutional Research at ODU reports those enrollments in cybersecurity as follows:

Fall 2015	11
Fall 2016	69
Fall 2017	121

The first 8 graduates completed their BS in Interdisciplinary Studies with a major in cybersecurity in 2017-18.

- Results of a survey sent to students enrolled in cybersecurity programs at Tidewater Community College, Thomas Nelson Community College, and Northern Virginia Community College demonstrate strong demand for the program. (To be described)

The student survey and results may be found in Appendix E.

Projected enrollment:

Year 1		Year 2		Year 3		Year 4 Target Year (2-year institutions)			Year 5 Target Year (4-year institutions)		
2019 - 2020		2020 - 2021		2021 - 2022		2022 - 2023			2023 - 2024		
HDCT	FTES	HDCT	FTES	HDCT	FTES	HDCT	FTES	GRAD	HDCT	FTES	GRAD
<u>150</u>	<u>100</u>	<u>150</u>	<u>100</u>	<u>175</u>	<u>125</u>	<u>175</u>	<u>125</u>	_____	<u>175</u>	<u>125</u>	<u>45</u>

Assumptions

- Retention: 90%
- Part-time students: 60% / Full-time students: 40%
- Full-time students credit hours per semester: 15
- Part-time students credit hours per semester: 6
- Full-time students graduate in 4 years
- Part-time students graduate in 6-8 years

Duplication

There is no baccalaureate degree program in cybersecurity offered by a public university in the Commonwealth of Virginia. Therefore, the proposed program would be the first of its kind in the state.

Projected Resource Needs for the Proposed Program

Resource Needs

Old Dominion University and the Center for Cyber Security Education and Research (CCSER) have sufficient resources to launch and sustain the proposed program. Specifically, faculty, staff, equipment, space, and library resources are available to launch and maintain the proposed program. The proposed program will allocate 1.0 FTE of instructional effort for every 24.0 FTE of enrollment. During the 2019-2020 academic year when the program is launched, a total of 4.1 FTE of instructional effort will be required, and it will rise to 5.2 FTE by the target year, 2023-2024.

Full-Time Faculty

One faculty member will contribute 50% (.5 FTE) of his teaching load when the proposed program is launched and into the target year.

Part-Time Faculty

Nine additional faculty members at the university will contribute less than half of their teaching loads in the proposed program. Combined, they will account for 3.6 FTE faculty when the program is launched. By the target year, the combined part-time faculty members will account for 4.7 FTE faculty.

Adjunct Faculty

No adjunct faculty members are required to launch and sustain the proposed program.

Graduate Assistants

No graduate assistants are required to launch and sustain the proposed program.

Classified Positions

A classified person—an administrative assistant—who supports the Center for Cyber Security Education and Research will assist with this proposed program. This person will devote approximately .25 FTE to the program, or \$7,500 in salary and \$2,783 in fringe benefits.

Targeted Financial Aid

No targeted financial aid is required to launch and sustain the proposed program.

Library

No new library resources are required to launch and sustain the proposed program. The University Libraries have adequate resources to support this program, including journals such as IEEE Security & Privacy, IEEE Transactions on Information Forensics and Security, and IEEE Transactions on Dependable and Secure Computing through the online IEEEExplore database.

Telecommunications

No new telecommunication equipment or software is needed to launch or sustain the proposed program.

Equipment (including computers)

No new equipment or related resources are needed to initiate and sustain this proposed program.

Space

No additional space is needed to initiate and sustain this proposed program.

Other Resources (specify)

No new resources will be required to launch or operate the proposed Bachelor of Science in Cybersecurity degree program.

Resource Needs: Parts A - D

Part A: Answer the following questions about general budget information.

- Has the institution submitted or will it submit an addendum budget request to cover one-time costs? Yes No
- Has the institution submitted or will it submit an addendum budget request to cover operating costs? Yes No
- Will there be any operating budget requests for this program that would exceed normal operating budget guidelines (for example, unusual faculty mix, faculty salaries, or resources)? Yes No
- Will each type of space for the proposed program be within projected guidelines? Yes No
- Will a capital outlay request in support of this program be forthcoming? Yes No

Part B: Fill in the number of FTE and other positions needed for the program				
	Program Initiation Year		Expected by Target Enrollment Year	
	2019- 2020		2023- 2024	
	On-going and reallocated	Added (New)	Added (New)***	Total FTE positions
Full-time faculty FTE*	0.50			0.50
Part-time faculty FTE**	3.60		1.10	4.70
Adjunct faculty				0.00
Graduate assistants (HDCT)				0.00
Classified positions	0.25			0.25
TOTAL	4.35	0.00	1.10	5.45

*Faculty dedicated to the program. **Faculty effort can be in the department or split with another unit.
*** Added **after** initiation year

Part C: Estimated resources to initiate and operate the program				
	Program Initiation Year		Expected by Target Enrollment Year	
	2019- 2020		2023- 2024	
Full-time faculty	0.50	0.00	0.00	0.50
salaries	\$75,000			\$75,000
fringe benefits	\$28,927			\$28,927
Part-time faculty (faculty FTE split with unit(s))	3.60	0.00	1.10	4.70
salaries	\$288,000		\$88,000	\$376,000
fringe benefits	\$111,082		\$33,942	\$145,024
Adjunct faculty	0.00	0.00	0.00	0.00
salaries				\$0
fringe benefits				\$0
Graduate assistants	0.00	0.00	0.00	0.00
salaries				\$0
fringe benefits				\$0
Classified Positions	0.25	0.00	0.00	0.25
salaries	\$7,500			\$7,500
fringe benefits	\$2,893			\$2,893
Personnel cost				
salaries	\$370,500	\$0	\$88,000	\$458,500
fringe benefits	\$142,902	\$0	\$33,942	\$176,844
Total personnel cost	\$513,402	\$0	\$121,942	\$635,344
Equipment				\$0
Library				\$0
Telecommunication costs				\$0
Other costs				\$0
TOTAL	\$513,402	\$0	\$121,942	\$635,344

Part D: Certification Statement(s)

The institution will require additional state funding to initiate and sustain this program.

Yes _____
Signature of Chief Academic Officer

No _____
Signature of Chief Academic Officer

Please complete Items 1, 2, and 3 below.

1. Estimated \$\$ and funding source to initiate and operate the program.

Funding Source	Program initiation year <u>2019</u> - <u>2020</u>	Target enrollment year <u>2023</u> - <u>2024</u>
Reallocation within the department <i>(Note below the impact this will have within the department.)</i>		
Reallocation within the school or college <i>(Note below the impact this will have within the school or college.)</i>		
Reallocation within the institution <i>(Note below the impact this will have within the institution.)</i>	\$513,402	\$635,344
Other funding sources <i>(Specify and note if these are currently available or anticipated.)</i>		

2. Statement of Impact/Funding Source(s). A separate detailed explanation of funding is required for each source used and a statement of impact on existing resources.

Reallocation within the Institution:

Funding for faculty in departments across Old Dominion University will be reallocated within the institution. The faculty are from the Center for Cyber Security Education and Research, as well as four colleges: College of Arts and Letters (Sociology and Criminal Justice; Philosophy and Religious Studies), Strome College of Business (Information Technology and Decision Science), Batten College of Engineering and Technology (Electrical and Computer Engineering; Modeling, Simulation and Visualization Engineering), and College of Sciences (Computer Science). The colleges and departments will maintain existing funding, and classes will be offered across various programs, including the proposed Bachelor of Science in Cybersecurity. No negative impact is anticipated for any degree program in any of the colleges or from any other areas of the university.

The Center for Cyber Security Education and Research (CCSER) will reallocate personnel funds within the center to accommodate the proposed program. This support from the CCSER will be available at the program's launch and through the target year. The faculty and administration anticipate no negative impact from the implementation of this program.

3. Secondary Certification.

If resources are reallocated from another unit to support this proposal, the institution will **not** subsequently request additional state funding to restore those resources for their original purpose.

Agree _____
Signature of Chief Academic Officer

Disagree _____
Signature of Chief Academic Officer

December 6, 2018

APPROVAL OF A MASTER OF SCIENCE DEGREE IN DATA SCIENCE AND ANALYTICS

RESOLVED that, upon the recommendation of the Academic and Research Advancement Committee, the Board of Visitors approves the proposed Master of Science degree in Data Science and Analytics in the Graduate School effective with the fall 2019 semester.

Rationale: Old Dominion University seeks approval to initiate a Master of Science in Data Science and Analytics to begin fall 2019. The program would be administered by the Graduate School.

The purpose of the Master of Science in data science and analytics degree program is to address the need for an expanding workforce that will help companies analyze data and integrate the outcomes with business processes to make them more productive. Data science and analytics is a multidisciplinary field that combines computer science, business analytics, and statistics to understand and leverage data to make advances and decisions that were not possible within previous organizational tools.

The curriculum will provide students with the skills and competencies that will make them successful in today's competitive, data-driven world. The program will prepare students to develop proficiencies in the fields of computational data analytics or in business intelligence and analytics. Specifically, they will be prepared to use state-of-the-art programming languages, tools, and software packages to perform analytics on complex data, develop statistical and machine-learning models, and organize, manage, and clean data for its maximum effectiveness in analysis and visualization.

The M.S. in data science and analytics will offer two concentrations – computational data analytics and business intelligence and analytics – both of which are designed to prepare students to apply knowledge and skills acquired in the program to specific areas of data science.

**STATE COUNCIL OF HIGHER EDUCATION FOR VIRGINIA
PROGRAM PROPOSAL COVER SHEET**

1. Institution Old Dominion University	2. Academic Program (Check one): New program proposal <input checked="" type="checkbox"/> Spin-off proposal <input type="checkbox"/> Certificate document <input type="checkbox"/>
3. Name/title of proposed program Data Science and Analytics	4. CIP code 11.0802
5. Degree/certificate designation Master of Science	6. Term and year of initiation Fall 2019
7a. For a proposed spin-off, title and degree designation of existing degree program 7b. CIP code (existing program)	
8. Term and year of first graduates Spring 2021	9. Date approved by Board of Visitors
10. For community colleges: date approved by local board date approved by State Board for Community Colleges	
11. If collaborative or joint program, identify collaborating institution(s) and attach letter(s) of intent/support from corresponding chief academic officers(s)	
12. Location of program within institution (complete for every level, as appropriate and specify the unit from the choices). Departments(s) or division of _____ School(s) or college(s) of <u>The Graduate School</u> Campus(es) or off-campus site(s) <u>Main campus, Norfolk</u>	
Mode(s) of delivery: face-to-face <input type="checkbox"/> hybrid (both face-to-face and distance) <input checked="" type="checkbox"/>	Distance (51% or more web-based) <input type="checkbox"/>
13. Name, title, and telephone number(s) of person(s) other than the institution's chief academic officer who may be contacted by or may be expected to contact Council staff regarding the modified program. Dr. Jeanie Kline, SCHEV Liaison, 757.683.3261	

Description of the Proposed Program

Program Background

Old Dominion University (ODU) in Norfolk, Virginia seeks approval to initiate a Master of Science in Data Science and Analytics degree program. The proposed program will be administered by the Graduate School at ODU. The target date of the program's initiation is fall semester 2019.

The purpose of the proposed Master of Science in Data Science and Analytics degree program is to address the need for an expanding workforce that will help companies analyze data and integrate the outcomes with business processes to make them more productive. Data science and analytics is a multidisciplinary field that combines computer science, business analytics, and statistics to understand and leverage data to make advances and decisions that were not possible within previous organizational tools. With the growth in computing hardware and software technologies, along with advancements in statistical and machine learning methods, industries are increasingly data driven. Organizations can now perform advanced analytics on large amounts of data and are able to move out of the arena of traditional business intelligence built around databases and data warehouses.

Faculty developed a curriculum that will provide students with the skills and competencies that will make them successful in today's competitive, data-driven world. The proposed program will prepare students to develop proficiencies in the fields of computational data analytics or in business intelligence and analytics. Specifically, they will be prepared to use state-of-the-art programming languages, tools, and software packages to perform analytics on complex data, develop statistical and machine-learning models, and organize, manage, and clean data for its maximum effectiveness in analysis and visualization.

The proposed MS in Data Science and Analytics will offer two concentrations, both of which are designed to prepare students to apply knowledge and skills acquired in the program to specific areas of data science. Those in the computational data analytics concentration will possess the core background knowledge in computer science and statistics fields and will be able to apply this knowledge to different types of data, and to structured and unstructured text, pictures, and videos. They will be able to perform predictive and prescriptive analytics. Not only will the program educate graduates in data analysis, it will also provide skills for graduates to extend results to broader interpretations of data in real-world contexts. The faculty will do this by teaching different methods to explore and visualize data and having graduates develop the ability to summarize and present the results of their analysis to both technical and non-technical audiences.

Graduates in the business intelligence and analytics concentration will learn the tools and methods used for the storage, access, and analysis of data to support informed business decision-making. Students will develop competencies in descriptive, predictive, and prescriptive analytics in a business context. They will be able to identify, collect, manage and analyze appropriate

organizational data and use the resulting information to make informed business recommendations.

Mission

The mission of the university states: Old Dominion University, located in the City of Norfolk in the metropolitan Hampton Roads region of coastal Virginia, is a dynamic public research institution that serves its students and enriches the Commonwealth of Virginia, the nation, and the world through rigorous academic programs, strategic partnerships, and active civic engagement.

The proposed MS in Data Science and Analytics aligns with this mission by providing a “rigorous academic program” that will prepare the next generation of data scientists to gain key analytic knowledge and skills in their respective fields, and ultimately to “enrich” the Commonwealth of Virginia, the nation, and the world with data-driven decision-making.

Online Delivery

The proposed Master of Science in Data Science and Analytics will be offered in a hybrid format, combining on-campus and online instruction. For online classes, Blackboard is Old Dominion University’s learning management system, which will be used for the proposed program, with extensive use of synchronous meetings in the Adobe Connect platform. Additionally, faculty utilize Adobe Connect or WebEx for weekly synchronous office hours and other real-time communication throughout each semester.

Old Dominion University has a robust distance learning network that supports faculty in web-based course development and delivery. Faculty who teach in the program are trained in course development and delivery through the Center for Learning and Teaching (CLT). Instructional designers, technologists, and other staff work with the library faculty to assist in implementing technology into classes and providing the latest in course development strategies.

Admission Criteria

The criteria for acceptance into the Master of Science in Data Science and Analytics will include the following:

- A completed online application and associated application fee
- A baccalaureate degree in computer science, electrical and/or computer engineering, mathematics, statistics, information system and technology or a related field from a regionally-accredited institution or an equivalent institution outside the U.S.; students holding bachelor’s degrees in an unrelated field will need the competency in topics related to basic statistics and computer science such as: differentiation and integration, vectors and matrices, determinants and matrix inverse, elementary statistics and probability, basic programming, software development and testing, and C++/java concepts.

- Official copies of transcripts of all regionally-accredited institutions attended (or equivalent non-U.S. institutions)
- Two letters of recommendation from individuals familiar with the applicant's professional and/or academic background
- A current resume
- A statement of professional goals
- GRE scores, with a 50% or better attainment on quantitative reasoning

Current scores on the Test of English as a Foreign Language (TOEFL) of at least 550 on the paper-based test (or 79- 80 on the iBT) are required for non-native English speakers.

Students with previously completed work at a regionally-accredited institution may submit a request for a maximum of 9 graduate credit hours to be transferred into a concentration or research area of the program. If approved by the graduate committee—the Graduate Program Director and faculty members representing each department associated with the degree—they will be added to their transcripts.

Target Population

The proposed Master of Science in Data Science and Analytics degree program will target undergraduates at ODU in various disciplines, including computer science, information technology, engineering, and health sciences. The program will also target those in the military and individuals working for federal, state, or local government or for government contractors who wish to gain advanced expertise in data science.

Curriculum

The proposed Master of Science in Data Science and Analytics is a 30-credit hour non-thesis degree program. The curriculum will offer two concentrations: computational data analytics and business intelligence and analytics.

The focus of the curriculum is to provide students with a solid foundation in data analytics. It will consist of a core, two concentrations, and a capstone project. The objective of the core is to lay the foundation that is required by data scientists working in any field. The core will establish proficiency in data discovery, collection, processing, and cleaning; competency in exploratory data analysis using statistics and visual analytics; and aptitude in statistical modeling implementation for predictive analytics.

The concentration in computational data analytics will provide students with opportunities to learn about different aspects of computational data analysis, such as machine learning, data visualization, web science, and natural language processing. Courses in this concentration are also offered to address relevant data analytics topics such as video analytics, algorithms and data structures, and information retrieval. The concentration in business intelligence and analytics will provide students with knowledge about database management systems, business

intelligence, information and communications technology, business analytics, and simulation modeling for business systems.

The capstone project brings together students in their final semester of study to synthesize knowledge from their coursework and apply it to solve real-world data analytics problems.

New courses are noted with an asterisk.

Program Requirements

Core Courses (15 Credits)

DASC 600	Introduction to Data Science	(3 credits)
STAT 603*	Statistical/Probability Models for Data Science	(3 credits)
CS 625*	Data Visualization	(3 credits)
STAT 604*	Statistical Tools for Data Science	(3 credits)
CS 624*	Data Analytics and Big Data	(3 credits)

Computational Data Analytics Concentration (12 credits)

Four of the following courses to be selected in consultation with the faculty advisor.

CS 521*	Machine Learning I	(3 credits)
CS 601*	Algorithms and Data Structures for Data Science	(3 credits)
CS 626*	Visual Analytics: Exploring and Analyzing Data Visually	(3 credits)
CS 632*	Web Science	(3 credits)
CS 721*	Machine Learning II	(3 credits)
CS 727*	Large Scale Video Analytics	(3 credits)
CS 733*	Natural Language Processing	(3 credits)
CS 735*	Information Retrieval	(3 credits)

Business Intelligence and Analytics Concentration (12 credits)

Two of the following courses to be selected in consultation with the faculty advisor

BNAL 503	Data Exploration and Visualization	(3 credits)
BNAL 515	Advanced Business Analytics with Big Data Applications	(3 credits)
BNAL 721	Simulation Modeling for Business Systems	(3 credits)

Two of the following courses to be selected in consultation with the faculty advisor

IT 650	Database Management Systems	(3 credits)
IT 651	Business Intelligence	(3 credits)
IT 652	Information and Communications Technology for Big Data	(3 credits)

Capstone Project

DASC 690*	Capstone Project	(3 credits)
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Capstone Project

The culminating course in the proposed MS in Data Science and Analytics degree program will bring students together with faculty and external partners. In consultation with a faculty advisor, along with a business or industry or government representative, students will be required to develop a project that aims to solve a data science problem in a real-world business, industry or

government setting. Faculty and business/industry/government representatives will serve as external mentors for the students during this experience.

Students will learn how to identify problems, gather data and information, understand the business system, define hypotheses, analyze and visualize the data, develop solutions, and effectively articulate and communicate ideas and results. The capstone course offers valuable experiences—through the collaborative efforts—to develop design thinking in data science and to exercise leadership in a team environment.

Appendix A provides sample schedules for full-time and part-time students. Course descriptions may be found in Appendix B.

Student Retention and Continuation Plan

The Graduate School, along with faculty who oversee this program will offer programming designed to ensure student success. Faculty will require new students to attend an orientation session, in person or online, which introduces the program, curriculum, requirements, expectations, faculty, facilities and other relevant resources students may access. In addition, faculty will publish an up-to-date curriculum and a long-range course schedule to help students plan their enrollment and time to completion. They will also hold advising sessions each semester and provide personalized advising throughout students' program of study. Finally, faculty, in collaboration with government/industry/business partners, will mentor students in curricular content and career opportunities.

When individual student performance demonstrates a lack of success, faculty will meet with the student to explore ways that will lead to success. These include holding additional advising sessions with the student, using peer mentors to connect students to each other and to their academic work, and having an external partner meet with the student to discuss areas of career interest.

Continuation within the program is contingent upon maintaining a 3.0 average in all academic coursework. Students who are unable to maintain the GPA requirements will meet with the Graduate Program Director and their academic advisor to develop a remediation plan designed to assist the student with academic success within the program.

Faculty

This proposed interdisciplinary degree program will have faculty members from the College of Sciences (Department of Computer Science and Department of Mathematics and Statistics) and from the Strome College of Business (Department of Information Technology and Decision Sciences). There will be six faculty members who will teach core and capstone classes. All hold PhDs and are tenured or tenure-track faculty members. They are active in research, publications, and teaching in areas related to data science and analytics. Combined, they have over 80 years' experience in postsecondary teaching.

Abbreviated CVs of faculty members are included in Appendix C.

Program Administration

The proposed Master of Science in Data Science and Analytics will be administered by the Graduate School, in collaboration with faculty from the College of Sciences and the Strome College of Business. A faculty member from Computer Science will be appointed as the Graduate Program Director (GPD). She or he will teach in the program and will have responsibility for setting class schedules, coordinating student meetings and activities, providing admission and enrollment information to the Graduate School, and meeting with the faculty, and dean or associate dean of Graduate School to discuss program matters.

A graduate committee, to include the GPD and faculty members representing each department associated with the degree, will be formed to review applicants for admission, evaluate the curriculum to ensure it meets student and employer needs, and conduct regular program assessments.

An administrative assistant in the Graduate School will support faculty and students in this program, with approximately 20% of his/her time devoted to the proposed degree program. The administrative assistant will help with class scheduling and coordination of appropriate paperwork for the program, including assessment materials that are provided to the dean, associate dean, and the Office of Academic Affairs.

Student Assessment

Students will be evaluated throughout the program using formative assessments, such as quizzes, tests, cases studies, papers, research projects, and presentations. Student learning outcomes cover many of the technical and management competencies required for the area of data science. Specifically, students graduating from the proposed program will have specific skills/knowledge in the area of data science and analytics. They will be able to:

1. Use statistical analyses to solve data analytics problems and make decisions.
2. Utilize descriptive and predictive analytics to identify a problem and improve business productivity.
3. Create visual representations of complex real world data that helps to identify patterns.
4. Apply modern programming languages and open source tools and packages to solve data science problems.
5. Employ effective communication skills to defend data analysis results and conclusions to both technical and non-technical audiences.
6. Explore and develop data models in order to recommend optimal solutions facing organizations.

Assessment Map for Core Courses in Proposed Program

Student Learning Objectives	Measures
<p>1. Statistical Methodology for Exploring Data Use statistical analyses to solve data analytics problems and make decisions.</p>	<p>DASC 600 – Introduction to Data Science Assessment: 85% of students will attain target on the statistical analysis final assignment rubric.</p> <p>DASC 690 – Capstone Assessment: 85% of students will attain target on the Capstone Project rubric – related to statistical exploration.</p>
<p>2. Data Analytics Utilize descriptive and predictive analytics to identify a problem and improve business productivity.</p>	<p>STAT 603 – Statistical/probability models for data science Assessment: 85% of students will attain target on the statistical modeling assignment rubric.</p> <p>DASC 690 – Capstone Assessment: 85% of students will attain target on the Capstone Project rubric – related to statistical modeling</p>
<p>3. Data Visualization Create visual representations of complex real world data that helps to identify patterns.</p>	<p>CS 625 – Data Visualization Assessment: 85% of students will attain target on the data visualization project rubric.</p> <p>DASC 690 – Capstone Assessment: 85% of students will attain target on the Capstone Project rubric – related to data visualization</p>
<p>4. Computer Programming Apply modern programming languages and open source tools and packages to solve data science problems.</p>	<p>CS 624 Data Analytics and Big Data Assessment: 85% of students will attain target on the final data science programming project rubric.</p> <p>CS 690 – Capstone Assessment: 85% of students will attain target on the Capstone Project rubric – related to programming.</p>
<p>5. Communication Skills Employ effective communication skills to defend data analysis results and conclusions to both technical and non-technical audiences.</p>	<p>CS 625 – Data visualization Assessment: 85% of students will attain target on the data visualization presentation rubric.</p>

	DASC 690 – Capstone Assessment: 85% of students will attain target on the Capstone Project rubric – related to communication skills
6. Research Explore and develop data models in order to recommend optimal solutions facing organizations.	STAT 604 - Statistical Tools for Data Science Assessment: 85% of students will attain target on the final data modeling assignment rubric. DASC 690 – Capstone Assessment: 85% of students will attain target on the Capstone Project rubric – related to final recommendations.

Employment Skills/Workplace Competencies

Graduates of the Master of Science in Data Science and Analytics will have the skills, ability, and workplace competencies needed for employment in the field of data science. Specifically, they will have:

- Proficiency in using state of the art programming languages, tools, and software packages to perform analytics on complex data including big data.
- Capability to develop statistical and machine learning models.
- Ability to organize, manage, and clean data for its maximum effectiveness in analysis and visualization.
- Proficiency in visually representing complex data to better understand the data and to effectively communicate to higher management the intricacies of data and its relationship with the organization processes.
- Ability to write professional code adhering to industry standard for building data science applications.
- Ability to lead teams in working various aspects of data science from retrieving and cleaning data to exploring and modeling data.

Program Assessment

The program will be assessed by faculty and administrators in the Graduate School, the College of Sciences, the Strome College of Business, and the Provost’s office. The review will be completed annually in the fall starting in the second year after the program is launched and will consist of:

- Analyzing retention and attrition rates in order to maximize the positive influences and improve the negative ones that affect program completion
- Analyzing the results of the ODU Graduate Student Satisfaction Survey for areas where additional student support is needed

- Analyzing graduate job placement to assess if the program is preparing students with the knowledge, skills and abilities for jobs in data science and evaluating the program's ability to meet market demands (following initial graduates' completion)

The results of these assessments will be used to evaluate the quality of the program, to stimulate program development, and to assess the role of the program in fulfilling ODU's institutional mission. The program review may (a) result in strategic decisions about the program, (b) identify areas of improvement, (c) make resource recommendations, (d) articulate considerations for expansion or consolidation, and/or (e) consider other aspects of programmatic quality with respect to policies and practices relative to:

- Student recruitment, admissions, advising, and retention;
- Enrollment projections including consideration of the context of the SCHEV 5-year benchmark and other on-going enrollment targets;
- Course descriptions and implementation;
- Curriculum changes and development;
- Faculty development and research activities;
- Facilities;
- Internal and external funding; and
- Description of strengths and weaknesses with attention to action items for the future.

The dean and associate dean in the Graduate School will read the program review each year to ensure that benchmarks are met and excellence is maintained. The Graduate School's annual evaluation of the program will be sent each year to the Vice Provost for Academic Affairs for review. The Vice Provost will offer guidance, as needed, for improvement, and will provide updates about the review to the Provost.

Old Dominion University maintains a robust program review process for graduate programs; as such, this master's program will have an internal review conducted by external faculty after five years (i.e., in fall of year 6). This review will include a self-study, a visit from faculty external to the program, and an action plan developed in concert with the Graduate Program Director, program faculty, and dean and associate dean of Graduate School.

Benchmarks of Success

Benchmarks of success for the proposed Master of Science in Data Science and Analytics degree program include the following student enrollment and graduate goals:

- 25-30 new students will be admitted when the program is launched, and will continue through the target year
- The program will graduate a minimum of 12 students annually by the completion of the target year
- 80% of the students who begin the program will successfully complete the program within five years of matriculation

- 80% of graduates will be employed in data science positions using knowledge acquired in their graduate studies within one year of program completion
- 80% of students will be satisfied with the program as determined by the university's Graduate Student Satisfaction Survey
- 80% of alumni will be satisfied with the program as determined by the university's Graduate Alumni Survey, administered within one year of program completion
- 80% of employers will be satisfied with the level of education and skill of graduates, as measured by an employer survey administered within one year of hire.

After the first year and subsequent years, periodic evaluations of the success of the program in meeting these benchmarks will be undertaken. If program benchmarks are not achieved, the Dean of the Graduate School, along with the Graduate Program Director and the program faculty, will examine the program's admissions policies, curriculum, instructional methods, advising practices, and course evaluations to determine where changes need to be made.

Expansion of an Existing Program

The proposed program is not an expansion of an existing certificate, concentration, emphasis, focus, major, minor, or track at Old Dominion University.

Relationship to Existing ODU Degree Programs

The proposed program is not similar or related to any existing master's program at Old Dominion University.

Compromising Existing Programs

No degree programs will be compromised or closed as a result of the initiation and operation of the proposed degree program.

Collaboration or Standalone

This is a standalone program. No other organization was involved in its development, and no other organization will collaborate in its operation.

Justification for the Proposed Program

Response to Current Needs (Specific Demand)

Data science and analytics is being recognized as the key discipline in utilizing ever-growing data to solve challenging problems facing multiple economic sectors. The latest U.N. E-Government Survey 2018¹ concludes that the fourth industrial revolution and convergence of big data technologies and machine learning is making a dramatic shift towards more data and machine-driven societies. The survey report states: “Data is being currently referred to as the new oil, the new raw material driving innovation and growth in both the private and public sectors. Indeed, data use will grow exponentially in the next decade and will offer the ability to systematically analyze and act in real time in solving more complex business problems, creating more competitive advantage and making better-informed decisions in a tightly connected world.”

Amazon CEO, Jeff Bezos, in a recent letter to shareholders, highlights the importance of data analytics and machine learning and how it impacts every part of the company. He wrote: "Machine learning drives our algorithms for demand forecasting, product search ranking, product and deals recommendations, merchandising placements, fraud detection, translations, and much more. Though less visible, much of the impact of machine learning will be of this type – quietly but meaningfully improving core operations."²

Data is growing exponentially at all levels of human activity. Just in the past two years, for example, more data has been generated than in the entire previous history of the human race.³ According to one estimate, by the year 2020, approximately 1.7 MB of data will be created every second for every person on the planet.³ With the growth in computing hardware and software technologies, along with advancements in statistical and machine learning methods, it is becoming feasible to work with this ever-growing data and address big challenges facing the society in various economic sectors. In general, multiple economic sectors can benefit from using a data-centered approach to reduce costs, make better and faster decisions, and develop new products and services.

Impact of Data Science and Analytics on Various Economic Sectors

Health. According to the American College of Cardiology,⁴ the aggregation of large quantities of structured and unstructured health information coupled with advanced data analytics will lead to a more patient-centered health care model that improves outcomes and reduce cost. That report claims that applying emerging computational data analytics techniques such as machine learning, natural language processing, and artificial intelligence to a large-scale biological, radiological, and translational bioinformatics datasets will help in defining dynamic patterns of health and disease. This will result in sustainable healthcare models that are driven by data and technology.

¹ <https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2018>

² <https://www.sec.gov/Archives/edgar/data/1018724/000119312517120198/d373368dex991.htm>

³ <https://www.forbes.com/sites/bernardmarr/2015/09/30/big-data-20-mind-boggling-facts-everyone-must-read/#ee9256c17b1e>

⁴ <http://www.onlinejacc.org/content/70/21/2696>

Finance and Banking. The financial and banking sector is using data to reduce fraudulent transactions, reduce customer churning, find new areas of growth, and reduce risk. With increased access to online transactions, bank frauds have become more sophisticated. According to a McKinsey report,⁵ banking data along with machine learning techniques can help institutions to fight against bank frauds. The finance and banking industry can use machine learning techniques to predict customers that are likely to reduce their business with the bank. This information can be used by the banks for target campaigning to reduce churn.⁶ Data analytics techniques can be used for risk assessment, stress testing, and developing early-warning systems.⁶

Defense. The Defense Logistics Agency created a new Strategic Data and Analysis office in March 2018 to help in making data-driven decisions.⁷ The new office will harness emerging tools and technology in the area of data analytics for reducing costs, making faster decisions, and offering new services. The office plans to use advanced predictive analytics approaches to forecast deployment needs. For example, by analyzing data from past deployments it is possible to predict the need of supply items by a unit in the future so as to supply the required items to the unit more efficiently, and at a cost reduction by avoiding emergency orders.

Retail. This is one of the sectors which is heavily utilizing data-centric approaches to enable targeted and personalized marketing. The data analytics, on a large scale, is enabling retailers to gain an innovative edge over the competition by using customer behavior analytics, optimize advertising and promotional investment, optimize supply with demand, detect fraud, and personalizing the in-store experience.⁸ For example, Starbucks' mobile app has more than 13 million active users who are creating a significant amount of data reflecting their purchasing habits.⁹ These data, along with data analytics approaches, are being used for personalizing the Starbucks experience, targeted and personalized marketing, determining new store locations, and updating menu options.

Skills Required and Shortage

Data science and analytics core skills are built upon statistics and computing fundamentals, which are acquired as part of an undergraduate curriculum. At the graduate level, students are prepared to solve real-world problems that require advanced analytics coupled with complex problem-solving skills. There is a growing need for training students at a graduate level where they obtain hands-on experience in data science and analytics techniques and methodologies to solve actual problems. More specifically, the skills required for most of the data scientists jobs are machine learning, big data, data visualization, predictive analytics, and problem-solving.

⁵ <https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/applying-analytics-in-financial-institutions-fight-against-fraud>

⁶ <https://www.mckinsey.com/industries/financial-services/our-insights/analytics-in-banking-time-to-realize-the-value>

⁷ <http://www.dla.mil/AboutDLA/News/NewsArticleView/Article/1454856/dla-creates-new-office-to-help-data-drive-decisions/>

⁸ <https://www.morganmckinley.co.uk/article/data-opportunities-and-challenges-within-retail-sector>

⁹ <https://www.forbes.com/sites/bernardmarr/2018/05/28/starbucks-using-big-data-analytics-and-artificial-intelligence-to-boost-performance/#45939b0065cd>

A report from the career and hiring company, Paysa,¹⁰ found that over 36% of data analytics and machine learning positions require a graduate level degree. Another report from IBM found that over 40% of data scientist positions require candidates to have a graduate degree.¹¹

According to the report from Paysa, the top 20 machine learning recruiters are investing over \$650M annually to hire data scientists.¹⁰ The recruiters' list includes Amazon, Google, Microsoft, Nvidia, Facebook, Intel, Rocket Fuel, GE, Cylance, and Oculus. The top annual investment is by Amazon of over \$200M with over 1100 jobs posting for machine learning. This is followed by Google with an annual investment of \$130M and the posting of over 550 jobs in machine learning. All this investment by various industries is disrupting the job market where current demand is far exceeding the supply. To make matter worse the growth in data scientists jobs is note leveling and it will put the demand for data scientists' skills in a dangerous zone. The IBM report written in collaboration with the Higher Education Forum and Burning Glass Technologies predicts that by 2020 the number of Data Science and Analytics job listing is projected to grow by 364,000.¹¹

The consulting firm, PricewaterhouseCoopers—or PwC—recently published a report that makes a case for investing in America's data science and analytics (DSA) talent.¹² The report claims that as companies in all sectors are becoming data-driven, there is an emergence of a hybrid economy. “The hybrid economy generates considerable demand for highly trained data scientists and an even greater demand for analytics-enabled professionals who possess hybrid skills: deep knowledge in a particular domain with strong ability in the use of data, analytics, and visualization tools. Despite this broad demand across all sectors, the US faces a significant shortfall in the number of data scientists and ‘data-enabled’ professionals. Closing this DSA talent gap—and enabling organizations to take full advantage of the value of data—will require significant expansion of strategic partnerships between business and higher education as well as investments in new talent development strategies.”

A report from 2011 published by the McKinsey Global Institute predicts that data-driven technologies will bring an additional \$300 billion of value to the U.S. healthcare sector alone, and by 2020, 1.5 million more “data-savvy managers” will be needed to capitalize on the potential of data¹³. The rise of data is creating similar opportunities/challenges in fundamental science. This report goes on to warn that in spite of a strong push in the U.S. at the federal, state, and local levels for more STEM education and more graduates who are underrepresented, the need for deep analytical talent is more specific even than this – more graduates with advanced training in statistics and machine learning will be necessary.

¹⁰ <https://www.paysa.com/press-releases/2017-04-17/6/us-companies-raising-1-billion>

¹¹ <https://www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=IML14576USEN&>

¹² <https://www.pwc.com/us/en/publications/assets/investing-in-america-s-dsa-talent-bhef-and-pwc.pdf>

¹³ https://www.mckinsey.com/~media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Big%20data%20The%20next%20frontier%20for%20innovation/MGI_big_data_exec_summary.a shx

Federal Initiative to Address Shortage of Talents

The Federal Big Data Research and Development Strategic Plan, published in May 2016 by the Executive Office of the President, National Science and Technology Council,¹⁴ emphasizes the importance of the emerging multidisciplinary field of data science for the overall economic development of the U.S. It concludes that the public-private partnerships, together with the education and training of future data scientists will be the key to improving the country's economy. According to the report, there are 60 institutions that offer a master's degree in data science, which is insufficient in addressing the workforce challenge. "The need is for both domain [concentration] experts who are trained in data science and "core" data scientists who focus on data science as their primary field of expertise. Individuals educated in data science at the undergraduate and graduate levels are vital to meeting needs across all sectors—industry, government, and academia."

The National Science Foundation report, "Realizing the Potential of Data Science," published in December 2016,¹⁵ highlights the importance of the emerging area of data science, the potential impact it will have on the U.S. economy, and the workforce requirements it will generate. "The ability to manipulate data and understand data science is becoming increasingly critical to current and future discovery and innovation." The report recognizes the role of National Science Foundation programs such as IGERT (Integrative Graduate Education and Research Traineeship) in the development of graduate program related to data science, and emphasizes the need for additional mechanisms to support the development of graduate programs in data science at various institutions.

The National Science Foundation sponsored a workshop in April 2016¹⁶ to identify research and workforce development challenges in this area. The workshop report recognizes that it is essential that computer scientists and statisticians collaborate to achieve significant progress in the emerging area of data science. It also highlights the challenges of developing new graduate data science programs to address the workforce development. "A successful foundational undergraduate and post-graduate data science education program should capitalize on cultural differences between disciplines that intersect the science of collection, conditioning, modeling, compression, and analysis of data. Such a program should combine the best practices of training in un-programmed learning (empirical experimentation labs, Kaggle competitions) and programmed learning (fundamental principles, analytical tools, formal methods, etc.)."

The challenge of producing a properly trained workforce with data science skills is enormous and higher education institutions will play an essential role in meeting this challenge. New graduate programs are needed to train both domain experts in the techniques of data science, and "core" data scientists who will be making advancements in the field of data science itself. Integrating data science as a discipline is paramount to developing a productive workforce that can address the needs across different sectors, and to ensuring that the United States remains economically competitive. To meet the explosive growth in demand for data scientist skills,

¹⁴ <https://www.nitrd.gov/pubs/bigdatardstrategicplan.pdf>

¹⁵ <https://www.nsf.gov/cise/ac-data-science-report/>

¹⁶ <http://www.cs.rpi.edu/TFoDS/>

several institutions in the U.S., including Virginia, have launched master’s programs, but they will not meet the current and future demand in the field.

Why Old Dominion University?

The economy in Hampton Roads is driven, in large part, by federal resources, with many organizations increasingly analyzing data for critical decision making. Among these entities are national research laboratories, large military organizations and government contractors, including the NASA Langley Research Center, Naval Station Norfolk, and Booz Allen Hamilton. NASA is collecting data from hundreds of satellites about Earth, the solar system, and the universe, utilizing big data analytics approaches to work with this significant amount of data.¹⁷ Naval Station Norfolk is looking at data analytics to predict when the fleet might be in danger of committing a major mishap, so that it can avoid a possible failure.¹⁸

Besides federal organizations, there are local industries such as Sentara Healthcare and Automatic Data Processing (ADP) that are becoming more data centered. Big data is essential to delivering sustainable, high quality, value-based healthcare; it is also critical to the success of new models of care such as clinically integrated networks (CINs) and accountable care organizations. Sentara Healthcare, based in Norfolk, is leading the way by leveraging big data analytics to build telehealth-supported electronic intensive care units and telehealth primary care support.¹⁹ In the burgeoning cloud-based computing enterprise, ADP, a fortune 500 company that provides business process outsourcing solutions, opened a new facility in Norfolk in 2016. ADP uses big data analytics at the core of its operations; one of their products, DataCloud, provides data analytics tools to help HR professionals gain insights from ADP workforce data.²⁰

Old Dominion University aims to meet the needs of these and other local entities—government and private industry—by providing the Master of Science in Data Science and Analytics to those who seek to become highly trained and skilled data scientists in their respective fields.

Employment Demand

The Bureau of Labor Statistics published a document that highlights career opportunities for data scientists.²¹ Some of the fields where graduates of the proposed program can be employed are business, E-commerce, finance, government, healthcare, science, social networking, telecommunication, politics, and utilities.

A recent report by IBM, Burning Glass Technologies, and the Business-Higher Education Forum suggests that the demand for data science skills is disrupting the job market.²² Key highlights from this report are:

¹⁷ <https://digit.hbs.org/submission/nasa-big-challenges-require-big-data-solutions/>

¹⁸ <https://news.usni.org/2017/11/13/navy-struggling-balance-training-maintenance-deployment-needs-service-looking-data-analysis-warn-readiness-problems>

¹⁹ <https://www.ncbi.nlm.nih.gov/pubmed/28199238>

²⁰ <https://www.adp.com/why-adp/data-cloud/overview.aspx>

²¹ <https://www.bls.gov/careeroutlook/2013/fall/art01.pdf>

²² <https://www.ibm.com/analytics/us/en/technology/data-science/quant-crunch.html> and <http://www.burning-glass.com/research-project/quant-crunch-data-science-job-market/>

- Twenty-five percent of employers hiring analysts prefer or require candidates to have a graduate degree, according to research from job market analytics firm, Burning Glass Technologies.
- In 2015 the number of job postings for data scientist and advanced analysts was 1629, 30% above the national average for all occupations.
- Among these job postings in 2015, the number of job posting that required a master or higher-level degree was 612. This number will grow to 678 by 2020.
- By 2020 the number of job openings requiring data science skills will reach 2.7 million.
- Data science jobs pay an average annual salary of \$105,000.
- Data science jobs remain open an average of 45 days, five days longer than the market average.
- The greatest demand for data science skills are in three sectors: information technology, finance and insurance, and professional services.
- By 2020, only 10% of the demand for employees skilled in data science, analytics and business analytics will be filled if there is not significant growth in advanced degree programs in these fields.

The number of “big data” jobs increased 63% during 2012, and some predictions estimate that 1.9 million new jobs will have been created by 2017 in the United States. Industry is currently facing a shortage of skilled workers. According to McKinsey,²³ “By 2018, the United States alone could face a shortage of 140,000 to 190,000 people with *deep analytical skills*.” The objective of the proposed Master of Science in Data Science degree program is to address this shortage.

Old Dominion University organized a workshop in December 2016 to assess the feasibility, demand, and requirements for a new graduate program in Data Science. Members of local industry and organizations such as Booz Allen Hamilton, Sentara Healthcare, and NASA Langley Research, more than 50 in all, participated in the workshop and were overwhelmingly supportive and encouraging that ODU should quickly establish an interdisciplinary graduate degree in Data Science, or Data Analytics. This new program should include a project-based Capstone course and emphasize critical thinking and problem solving in addition to quantitative skill in statistics, machine learning and visualization.

According to the BLS, employment of computer and information research scientist occupations is projected to grow 19% from 2016 to 2026,²⁴ “much faster than the average” for all occupations. The BLS reports that the “typical entry-level education” for computer and information research scientist occupations is a master’s degree. Demand for these workers will stem from greater emphasis on cloud computing, the collection and storage of big data, and information security.

²³ <http://www.mckinsey.com/business-functions/business-technology/our-insights/big-data-the-next-frontier-for-innovation>

²⁴ <https://www.bls.gov/ooh/computer-and-information-technology/computer-and-information-research-scientists.htm>

The BLS also reports that overall employment of mathematicians and statisticians is projected to grow 33% from 2016 to 2026, “much faster than the average” for all occupations.²⁵ The “typical entry-level education” for mathematicians and statisticians occupations is a master’s degree. Businesses will need these workers to analyze the increasing volume of digital and electronic data. The average growth rate for all occupations is 7%.

According to the BLS Geographic Profile for Computer and Information Research Scientists, the Commonwealth of Virginia has the second highest employment level in this occupation, second to California:²⁶

State	Employment (in thousands)	Employment per thousand jobs	Location quotient	Hourly mean wage	Annual mean wage
<u>California</u>	4,950	0.31	1.64	\$60.39	\$125,620
<u>Virginia</u>	2,550	0.68	3.59	\$60.96	\$126,800
<u>Maryland</u>	2,490	0.94	4.99	\$54.38	\$113,110
<u>New Jersey</u>	1,530	0.39	2.04	\$60.52	\$125,880

The Commonwealth of Virginia is among the top states with the highest concentration of jobs and location quotients for this occupation. The location quotient is the ratio of the area concentration of occupational employment to the national average concentration. A location quotient greater than one indicates the occupation has a higher share of employment than average, and a location quotient less than one indicates the occupation is less prevalent in the area than average.

In the June 2018 Bureau of Labor Statistics publication called Beyond the Numbers,²⁷ the employment change for mathematical science occupations projected for 2016-2026 follows (with numbers in thousands).

Occupational title	Employment		Change, 2016–26	
	2016	2026	Number	Percent
Total, all occupations	156,063.8	167,582.3	11,518.6	7.4
Mathematical science occupations	180.7	231.0	50.4	27.9
Actuaries	23.6	28.9	5.3	22.5
Mathematicians	3.1	4.0	0.9	29.7
Operations research analysts	114.0	145.3	31.3	27.4
Statisticians	37.2	49.8	12.6	33.8

²⁵ <https://www.bls.gov/ooh/math/mathematicians-and-statisticians.htm>

²⁶ <https://www.bls.gov/oes/current/oes151111.htm#st>

²⁷ <https://www.bls.gov/opub/btn/volume-7/big-data-adds-up.htm>

Commonwealth of Virginia

The Commonwealth of Virginia recognizes the importance of data science and is already investing in this area. One of the initiatives, Virginia Longitudinal Data System,²⁸ enables data analysis on a diverse set of large datasets. Executive Directive 7 (2016) makes the case for leveraging the use of shared data and analytics.²⁹ The directive states:

In order to continue the Commonwealth's advancement towards a New Virginia Economy that draws on all of the Commonwealth's vast resources, it is important that state agencies have access to all information necessary to better provide services to our citizens. Increasing the use of shared data and analytics among Virginia agencies through a comprehensive and coordinated effort will improve the provision of services and outcomes, maximize the use of resources, and increase the return on investment of our citizens' tax dollars in their government. Increasing data sharing, correlation, and analysis capacity will enable the state to achieve efficiencies in the administration of state programs and services, and allow state government to more efficiently and effectively address issues related to public health, public safety, education, and quality of life.

Recently, The Commonwealth started GO Virginia, which provides funds to diversify the economy of regions.³⁰ Data analytics has been identified as the best opportunity for increasing the economic prosperity of Regions 5,³¹ which is comprised of the cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg; and the counties of Accomack, Isle of Wight, James City, Northampton, Southampton, and York. Additionally, the Commonwealth of Virginia has made a number of non-sensitive datasets available in the public domain.³² This will enable data scientists to build useful applications around the open data set potentially leading to economic opportunities.

A recent report from the Center for Data Innovation evaluates different states, including Commonwealth of Virginia, in terms of a series of indicators in three categories: the availability of high-value datasets, the creation of important technologies, and the development of human and business capital.³³ For one of the metrics, "Data Science Job Listings," which is a measure of job postings for data scientists as a share of total posted job listings, the Commonwealth of Virginia is ranked #4.

Virginia Labor Market Information

The Virginia LMI³⁴ website provides long term (2016-2026) projected employment information about occupations that require skills in Data Science and Analytics such as:

²⁸ <https://vlids.virginia.gov/>

²⁹ <https://governor.virginia.gov/media/6007/ed-07-leveraging-the-use-of-shared-data-and-analytics.pdf>

³⁰ <http://www.dhcd.virginia.gov/index.php/go-virginia.html>

³¹ <http://www.dhcd.virginia.gov/images/GoVA/Region%205%20G&D%20Plan.pdf>

³² <http://data.virginia.gov/>

³³ https://www.datainnovation.org/2017/07/the-best-states-for-data-innovation/?mc_cid=876e528114&mc_eid=ad73800a40

³⁴ <https://data.virginialmi.com/>

Occupation	Total change for 2016-2026 (%)	Annual Average Growth (%)
Operations Research Analysts	36.53	3.16
Mathematical Scientists	35.94	3.12
Statisticians	43.36	3.67
Computer Systems Analysts	12.95	1.23
Software Developers	32.71	2.87

The annual average percent change for computer and mathematical occupations for 2016-2026 is 1.69% as compared to the 0.89% for all occupations during that time period. The total percent change for Computer Mathematical occupations from 2016-2026 is 18.23% as compared to 9% change for all occupations.

Hampton Roads

The Hampton Roads area includes organizations that are keenly interested in this program. Letters of support from several of these employers may be found in Appendix D.

Employer Survey

The results of survey among employers are provided in Appendix E.

Appendix F contains current job announcements demonstrating a need for prospective employees with the knowledge that this data science degree program would provide.

Student Demand

Evidence of student demand is available with the following data:

1. Student Survey:

https://odu.co1.qualtrics.com/jfe/preview/SV_afy4dgxJokEzvjD?Q_CHL=preview

The results of student survey are presented in Appendix G.

2. Alumni survey or second student survey

Projected enrollment:

Year 1		Year 2		Year 3		Year 4 Target Year (2-year institutions)			Year 5 Target Year (4-year institutions)		
2020 - 2021		2021 - 2022		2022 - 2023		2023 - 2024			2024 - 2025		
HDCT	FTES	HDCT	FTES	HDCT	FTES	HDCT	FTES	GRAD	HDCT	FTES	GRAD
<u>25</u>	<u>15</u>	<u>28</u>	<u>18</u>	<u>28</u>	<u>18</u>	<u>28</u>	<u>18</u>	_____	<u>30</u>	<u>22</u>	<u>14</u>

Assumptions

Retention percentage: 80%

Percentage of full-time students: 25% Percentage of part-time students: 75%

Full-time student credit hours per semester: 12

Part-time student credit hours per semester: 6

Full-time students graduate in 1.5 years

Part-time students graduate in 3 years

Duplication

The Commonwealth of Virginia currently has six public institutions—College of William and Mary, George Mason University, Radford University, University of Virginia, Virginia Commonwealth University, and Virginia Tech—that offer master’s programs that are similar or related to the proposed Master of Science in Data Science and Analytics degree program.

The College of William & Mary (WM) offers a Master in Science in Business Analytics that requires 30 credit hours.

Similarities to ODU: The WM program is similar to the proposed program in many respects. Both require 30 credit hours (though the online version requires 32 hours) and both include a 3-credit hour capstone project. Several courses in the WM program cover comparable content as that in the proposed program. These include Intermediate Probability and Statistics at WM and Statistical/Probability Models for Data Science at ODU and Data Visualization (WM) and Data Visualization (ODU).

Differences from ODU: The WM program has no electives and focuses entirely on business analytics. In contrast, the proposed program at ODU is interdisciplinary, and it offers both a core component and the choice of two concentration areas. The WM core component consists of 18 credits including a three credit hour capstone project. In addition, ODU’s proposed program consists of 12 elective credits from one of the two concentrations. Some core courses in the WM program, such as Optimization, Heuristics Algorithms, have no counterparts in the ODU program. On the other hand ODU’s core course, Introduction to Data Science, is not available in the WM program.

George Mason University (GMU) offers a Master of Science in Data Analytics Engineering that requires 30 credits of graduate course work.

Similarities to ODU: This MS degree has a similar structure as the proposed program at ODU. It has two components: a core consisting of 15 credits and a concentration consisting of 15 credits. Content covered in two GMU core courses is similar to content in the proposed core. The GMU course, Analytics: Big Data Information, overlaps with ODU's Data Analytics and Big Data. Also, the GMU course Applied Statistics and Visualization for Analytics covers comparable content in two ODU courses, Statistical Tools for Data Science and Data Visualization. Another similarity is the capstone project that is required in both programs.

Differences from ODU: Unlike the proposed program, the GMU program does not have an Introduction to Data Science. In addition, there are variations in content in core courses between the two programs. For example, the GMU program has a core course option in operation research. Such a course is not part of the proposed program core.

Radford University (RU) offers a Master of Science in Data and Information Management, requiring 30 credit hours.

Similarities to ODU: The emphasis of this program is on the use of technology for data management for both traditional and big data. The program has a fixed set of courses and a capstone project.

Differences from ODU: There are major differences between the two programs. The ODU program is interdisciplinary and the RU program focuses on one discipline. None of the ODU core courses are taught in the RU program. Data Visualization, Algorithms and other data science topics that are in the proposed program are absent from the MS program at Radford University. Instead, RU offers core courses that cover database administration, data warehousing, and data mining.

University of Virginia (UVA) offers a Master of Science in Data Science consisting of 30 credit hours.

Similarities to ODU: The UVA program is a one-year professional degree and is interdisciplinary in nature (similar to the ODU program), with the Departments of Computer Science, Statistics, and Systems and Information Engineering providing the coursework. It also has a similar structure as the proposed program, consisting of nine core courses with varying number of credit hours, two capstone projects and two electives. Core courses in the proposed program cover much of the content as that of the UVA program.

Differences from ODU: The UVA program requires two capstone projects each carrying one credit, in comparison to one 3-credit capstone project in the ODU program. At UVA, a core course, Ethics of Big Data II, has no common content with core courses of the ODU program. At ODU, core courses, Statistical/Probability Models for Data Science and Data Analytics and Big Data, have no equivalents in the UVA curriculum.

Virginia Commonwealth University (VCU) offers a Master of Decision Analytics that requires 30 credit hours.

Similarities to ODU: The VCU School of Business offers the Master of Decision Analytics degree. It has a similar structure as the proposed MS in Data Science: a core consisting of five courses (15 credit hours) and five approved electives (15 credit hours) offered by several departments in the college. The VCU course, Statistical Analysis and Modeling, is similar to the proposed ODU course, Statistical Tools for Data Science.

Differences from ODU: There are major differences between the VCU program and the proposed program. The ODU program is interdisciplinary, with a core in the proposed program combining computer science and statistics; the VCU program consists of core courses in business that are not part of the ODU core. Other than the statistical analysis course in the core, there is almost no overlap in content between the VCU program and the ODU program.

Virginia Tech (VT) offers two graduate programs related to data science, one of which is a stand-alone master's program; the other is a concentration within the MS in Business Administration.

(1) Master of Arts in Data Analysis and Applied Statistics, 33 credit hours.

Similarities to ODU: The structure of the Data Analysis and Applied Statistics program is similar to the proposed program. The VT program has a core consisting of 21 credit hours and 12 credit hours in electives. Comparable content is covered in the VT course, Theoretical Statistics, and the ODU course, Statistical/Probability Models for Data Science. In addition, VT's Statistics in Research I-II courses have content in common with ODU's Statistical Tools for Data Science. Both programs require a capstone project.

Differences from ODU: The VT program consists of 33 credit hours and the proposed program at ODU is 30 credit hours. The proposed program at ODU is interdisciplinary, and VT's program is offered by the statistics department at Virginia Tech; thus, it is predominantly a program in statistics and applications. There are no computer science courses in the VT program, whereas computer science is a key component of the ODU core.

(2) Master of Science in Business Administration with a concentration in Business Analytics

The concentration in business analytics requires the completion of 30 credit hours. It is designed to give students the necessary business knowledge, technical expertise, and professional skills to be effective business analytics practitioners. It teaches students quantitative modeling techniques for descriptive, predictive, and prescriptive analytics.

The MSBA-BA concentration covers content that is similar to the proposed MS in Data Science, and both require a capstone project. However, the concentration is not a stand-alone program, and does not offer the full depth and breadth of the coursework offered in the proposed ODU degree program.

Location

Old Dominion University is in south Hampton Roads and will be the only program in this area.

Enrollments ³⁵	Fall 2013	Fall 2014	Fall 2015	Fall 2016	Fall 2017
College of William and Mary				47	84
George Mason University		38	125	236	294
Radford University				3	11
University of Virginia		47	53	49	37
Virginia Commonwealth University				60	88
Virginia Tech				3	2
Graduates ³⁶	2012- 2013	2013- 2014	2014- 2015	2015- 2016	2016- 2017
College of William and Mary					45
George Mason University			1	27	67
Radford University					
University of Virginia			43	49	50
Virginia Commonwealth University					40
Virginia Tech					4

Projected Resource Needs for the Proposed Program

Resource Needs

The Graduate School and Old Dominion University have sufficient resources to initiate and sustain the proposed program. The institution has existing faculty, staff, equipment, space, and library resources that will support the program. The proposed program allocates 1.0 FTE of instructional effort for every 9.0 FTE of enrollment. The proposed program will therefore require a total of 2 FTE of instructional effort in 2020-2021 when it is launched and 2.25 by the target year, 2024-2025.

Full-time faculty

One faculty member whose course load represents 50% or more of their teaching requirements will teach in the proposed MS in Data Science and Analytics. The faculty load will be .75 FTE when the proposed program is launched and through the target year.

Part-time faculty

Five faculty members in the Departments of Computer Science, Mathematics and Statistics, and Information Technology and Decision Sciences have part-time teaching loads (below 50%) in the proposed program. These faculty will contribute 1.0 FTE when the program is launched and 1.5 by the target year.

³⁵ http://research.schev.edu/enrollment/E16_Report.asp

³⁶ http://research.schev.edu/Completions/C1Level2_Report.asp

Adjunct faculty

No adjunct faculty are required to launch and sustain the proposed degree program.

Graduate Assistants

No graduate assistants are required to launch and sustain the proposed degree program.

Classified Positions

There is currently a full-time classified position within the Graduate School, an Administrative Assistant, who will assist faculty who teach in the proposed MS in Data Science and Analytics. The program will require .20 FTE of classified support to initiate and this level of effort will remain constant through the target year. Salary for the administrative assistant will be \$7,500 in salary and \$2,893 in benefits.

Targeted financial aid

No targeted financial aid is required or designated to initiate and sustain the proposed degree program.

Equipment (including computers)

No new equipment, including computers, is necessary to launch and sustain the proposed degree program.

Library

No new library resources are required to launch and sustain the proposed degree program. The University Libraries will be able to fully support the MS in Data Science and Analytics. Major journals in the field, including *International Journal of Data Science and Analytics*, *ACM Transactions on Knowledge Discovery from Data*, *Statistical Analysis and Data Mining*, *Big Data*, and many others, are available in the University Libraries. Obtaining articles is extremely easy through (1) online subscriptions held by the university, (2) physical subscriptions for some journals, and (3) rapid delivery via Interlibrary Loan.

Telecommunications

No new telecommunications resources are required to launch and sustain the proposed degree program.

Space

No new space is required to launch and sustain the proposed degree program.

Other Resources (specify)

No additional resources are required to launch and sustain the proposed degree program.

Resource Needs: Parts A - D

Part A: Answer the following questions about general budget information.

- Has the institution submitted or will it submit an addendum budget request to cover one-time costs? Yes No
- Has the institution submitted or will it submit an addendum budget request to cover operating costs? Yes No
- Will there be any operating budget requests for this program that would exceed normal operating budget guidelines (for example, unusual faculty mix, faculty salaries, or resources)? Yes No
- Will each type of space for the proposed program be within projected guidelines? Yes No
- Will a capital outlay request in support of this program be forthcoming? Yes No

Part B: Fill in the number of FTE and other positions needed for the program				
	Program Initiation Year		Expected by Target Enrollment Year	
	2020- 2021		2024- 2025	
	On-going and reallocated	Added (New)	Added (New)***	Total FTE positions
Full-time faculty FTE*	0.75			0.75
Part-time faculty FTE**	1.00		0.50	1.50
Adjunct faculty				0.00
Graduate assistants (HDCT)				0.00
Classified positions	0.20			0.20
TOTAL	1.95	0.00	0.50	2.45
*Faculty dedicated to the program. **Faculty effort can be in the department or split with another unit.				
*** Added after initiation year				

Part C: Estimated resources to initiate and operate the program				
	Program Initiation Year		Expected by Target Enrollment Year	
	2020- 2021		2024- 2025	
Full-time faculty	0.75	0.00	0.00	0.75
salaries	\$84,642			\$84,642
fringe benefits	\$32,646			\$32,646
Part-time faculty (faculty FTE split with unit(s))	1.00	0.00	0.50	1.50
salaries	\$112,856		\$56,428	\$169,284
fringe benefits	\$43,529		\$21,764	\$65,293
Adjunct faculty	0.00	0.00	0.00	0.00
salaries				\$0
fringe benefits				\$0
Graduate assistants	0.00	0.00	0.00	0.00
salaries				\$0
fringe benefits				\$0
Classified Positions	0.20	0.00	0.00	0.20
salaries	\$7,500			\$7,500
fringe benefits	\$2,893			\$2,893
Personnel cost				
salaries	\$204,998	\$0	\$56,428	\$261,426
fringe benefits	\$79,068	\$0	\$21,764	\$100,832
Total personnel cost	\$284,066	\$0	\$78,192	\$362,258
Equipment				\$0
Library				\$0
Telecommunication costs				\$0
Other costs				\$0
TOTAL	\$284,066	\$0	\$78,192	\$362,258

Part D: Certification Statement(s)

The institution will require additional state funding to initiate and sustain this program.

_____ Yes _____
Signature of Chief Academic Officer

X_____ No _____
Signature of Chief Academic Officer

Please complete Items 1, 2, and 3 below.

1. Estimated \$\$ and funding source to initiate and operate the program.

Funding Source	Program initiation year 20 <u>20</u> - 20 <u>21</u>	Target enrollment year 20 <u>24</u> - 20 <u>25</u>
Reallocation within the department <i>(Note below the impact this will have within the department.)</i>		
Reallocation within the school or college <i>(Note below the impact this will have within the school or college.)</i>		
Reallocation within the institution <i>(Note below the impact this will have within the institution.)</i>	\$284,066	\$362,258
Other funding sources <i>(Specify and note if these are currently available or anticipated.)</i>		

2. Statement of Impact/Funding Source(s). A separate detailed explanation of funding is required for each source used and a statement of impact on existing resources.

Reallocation within the Institution

The College of Sciences will be the primary funding source to launch and sustain the proposed degree program. In addition, the Graduate School and the Strome College of Business will also contribute to the operation of the program. College of Sciences funding includes reallocation and sharing of faculty resources used for computer science and mathematics/ statistics graduate programs. Specifically, faculty who teach in those programs will also teach in the proposed program. No adverse impact is anticipated on academic programs in the College of Sciences as a result of opening the proposed program.

The Graduate School will provide operational funding for the program, and the Department of Computer Science and Department of Information Technology and Decision Sciences will provide faculty for course offerings in the concentrations. No adverse impact is anticipated on academic programs in either department or the Graduate School as a result of opening the proposed program.

3. Secondary Certification.

If resources are reallocated from another unit to support this proposal, the institution will **not** subsequently request additional state funding to restore those resources for their original purpose.

Agree _____
Signature of Chief Academic Officer

Disagree _____
Signature of Chief Academic Officer

December 6, 2018

APPROVAL TO RENAME THE SCHOOL OF PHYSICAL THERAPY AND
ATHLETIC TRAINING THE SCHOOL OF REHABILITATION SCIENCES

RESOLVED that, upon the recommendation of the Academic and Research
Advancement Committee, the Board of Visitors approves renaming the School of
Physical Therapy and Athletic Training the School of Rehabilitation Sciences effective
July 1, 2019.

Rationale: The School of Physical Therapy and Athletic Training has progressed
from offering only a Doctorate in Physical Therapy (DPT) to also offering
a Master of Science in Athletic Training and a Ph.D. in Kinesiology and
Rehabilitation. The current name of the school does not represent the three
programs and would not accurately portray programmatic expansion, such
as the potential addition of Occupational Therapy.

The proposed name—School of Rehabilitation Sciences—reflects the
commonalities of the current programs and would continue to be
appropriate for new related programs. The name is consistent with the
vision of the College of Health Sciences, which is to “advance healthcare
education and research through interdisciplinary and global connections.”
Further, the proposed name is commonly used for similar schools across
the country (e.g., George Mason University, Temple University, and the
University of Kentucky). The new name will better represent the work
taking place in the school and the future of rehabilitation sciences
education and research at Old Dominion University.