Immersive Media Design Major Report
April 26, 2016

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Ben Bederson, Professor & Associate Provost of Learning Initiatives
**Introduction**

The applications for virtual and augmented reality (VR and AR) are vast and high impact. The National Academy of Engineering has identified Enhancing Virtual Reality as one of the Grand Challenges for the 21st century, and VR and AR are on their way to evolving as the eighth mass market, following print, recordings, cinema, radio, TV, the Internet, and mobile technology. Just as mobile technology has connected everyone to the world around them, immersive virtual and augmented reality is the next leap forward in the ever-expanding information revolution. By overlaying, or augmenting, digital information on top of real-world settings, immersive augmented reality allows people from all walks of life—health care professionals, educators, industrial workers, artists, and everyday people—to see and use the information that matters most to them. The creation of such immersive environments—through mediums like digital photography, video journalism, and personalized design for consumer and industrial products—demands a new way of thinking. To answer this demand, we propose to establish an Immersive Media Design Major (IMDM), through a unique cross-campus collaboration of expert faculty members and resources at the University of Maryland, College Park (UMD). This multidisciplinary major will strengthen the scientific and scholarly foundations needed to advance the extraordinary potential of virtual and augmented reality applications. The program will contribute to economic sectors and industries that are focal points for Maryland, including defense, life sciences, computing, virtual gaming technologies, and digital health care. In addition, it will catalyze direct linkages to the computer games industry that is heavily influenced by synergies between computing, education, engineering, art, and design. Our major will also be a catalyst for securing large, multi-institutional research and education grants from nearby federal agencies and other sources, promising to position Maryland as a leader in our nation’s new economy based on technology and innovation.

**Educational Outcomes**

IMDM will significantly enrich the quality of visual thinking and data exploration, and will elevate Maryland to a leadership position in the emerging field of human visual augmentation. A major goal of the program is to provide education and training to undergraduate students to prepare for the new visual IT workforce. The program will have a sustained commitment to education and outreach, with the dual goals of training the next generation of researchers and clinicians, and attracting new and diverse participants. Program faculty will be deeply involved in teaching both undergraduate and graduate students in their labs, and the program’s education and outreach programs will enrich our local communities. In this truly cross-disciplinary major, the structure of the courses will mirror the employment environment that students will enter, by bridging humanities and STEM fields. Students in computing, art, education, engineering, behavioral and social sciences, information and business—working together—will discover the
convergence of their differing perspectives and pave the way for groundbreaking new research. These uniquely well-equipped students will emerge into Maryland’s educated workforce in three to five years, able to pursue a robust array of in-demand careers, and poised to drive innovation in a broad range of industries with their hands-on knowledge of novel digital technology.

The students will emerge ready to take on challenges in a number of new careers in areas that will be shortly becoming mainstream in the AR/VR ecosystem. Some of these include:

1. Computer Games industry
2. Recording and streaming Live Events
3. Retail
4. Real Estate
5. Education
6. Healthcare
7. Defense
8. Engineering

These are also highlighted in the attached graphic from the Goldman Sachs report on the future of AR/VR (Jan 2016).

**Economic Outcomes**

The State of Maryland and greater Washington region are poised to capitalize on the virtual and augmented reality industry. The region has many startups, including Machine Elf (program for developers, architects and engineers to better communicate building plans via a virtual reality headset), Agora VR (software that lets users attend seminars, university lectures or business meetings with the help of a virtual reality headset), VisiSonics (hardware and software designed to bring life-like audio to gaming, virtual-reality environments, movies and music), Brightline Interactive (created virtual reality gaming experience for Toyota to accurately illustrate the dangers of distracted driving), and Sensics (builds open-source virtual reality headsets and software).

By training students to be thinkers as well as makers and doers, we can incentivize them to transition their study into practice. Specifically, our major will coordinate with an annual programming and building contest (VR Camp), bringing together hundreds to thousands of student attendees, where students take what they love, fuse it with technology, and build
something the world has never seen. Unlike other “hackathons,” these events will bring together students that are exclusively focused on VR and AR, but from an interdisciplinary point of view, including computer scientists, engineers, psychologists, and artists. Through significant collaboration with the local and national digital media industry, we anticipate at least 10 startups will arise from this initiative over a period of five years, further showcasing Maryland as a unique location for entrepreneurial and innovative business opportunities in the country.

Further, Maryland has one of the largest clusters of computer gaming companies on the East Coast, with over 50 companies involved in games and games-related ventures. Our links to this growing industry remain strong, including a steady flow of graduates to both established companies and startups. Oculus VR co-founders and their families committed $38 million to UMD in September to help establish our leadership in virtual and augmented reality. UMD is also strongly supported by NVIDIA, a leading vendor of visual computing processors, through the company’s Center of Excellence program. According to a 2010 report prepared by Sage Policy Group for the Maryland Department of Business and Economic Development, “Digital media is a $5.5 billion industry in Maryland. Once one considers multiplier effects, the industry is associated with $15 billion in economic activity in Maryland each year; in fiscal year 2008, Maryland’s digital media industry contributed more than $1 billion to State and local government revenue.” We are uniquely positioned to catalyze this rapidly growing segment of the local and national economy. We are also well-suited to leverage community outreach and education opportunities through the University of Maryland Center for Art and Knowledge, created in partnership with the Phillips Collection, the new Arts District in the Prince George’s County, as well as the Motor House and Open Works (http://www.baltimoreartsrealty.com) projects in downtown Baltimore.

**Overview of the Major**

The new Immersive Media Design Major (IMDM) is an organized framework for the pursuit of interdisciplinary training and integrated knowledge directed towards creative and collaborative practices in immersive and other emerging media. The global digital media and virtual and augmented reality industry is rapidly becoming more interdisciplinary, with engineers, designers, software developers, and artists working collaboratively. The IMDM combines this collaborative structure with a rigorous theoretical underpinning within the scholarly traditions of our campus to mirror the digital and technological industry’s trend toward interdisciplinary teams. Graduates of this program will be strongly prepared for the dynamic and changing expectations of the marketplace.

This document outlines a proposal for a new major that will bridge several academic disciplines and units on the University of Maryland, College Park campus including computer science, studio art, geography, engineering and English. This new major leverages the academic
strengths of the College Park campus in creation of a distinctive, interdisciplinary multi-track program.

The proposed is a response to the changing digital and immersive media industry, the academic interests of incoming students and the shifting demands of today’s collaborative workplace. Interdisciplinary teams of instructors will teach the major’s core classes. Pairings include computer science and art studio, geography and engineering, and English and computer science. Students will work in interdisciplinary teams to complete projects based upon the expertise of the instructor pairings.

In addition, this major is infused with courses that will provide theory and context to new technologies via history and culture, propagating students who are thinkers as well as makers and doers. The courses will challenge students to apply theoretical and academic content to virtual, visual, performative, computational and physical projects. Students will incorporate knowledge of software development, coding structure, mechanical functions, visual aesthetics, storytelling, resource optimization and audience considerations to produce innovative results. Initial foci will include game design, augmented and virtual reality, physical computing and digital fabrication.

Currently the proposed major has different tracks of academic study to afford mastery in an area of study. For example, Track One focuses more on computer science coursework whereas Track Two focuses more on Studio Art coursework. Students become well versed in one field while learning to apply that knowledge within an interdisciplinary context. These courses provide significant opportunities for academic innovation on this campus.

As with any new program, this proposed major will need a significant investment of resources for hiring of new faculty, staff, and teaching assistants. In addition, for sustained and effective operations, the major will need an operational base budget commensurate with the scale of the innovative and interdisciplinary program.

This report highlights our conceptual framework for an IMDM major at UMD. The pieces needed to distinguish us as a preeminent leader in VR and AR are already in place: vibrant student interest, substantial private support, stellar faculty expertise and a groundswell of public curiosity in these new and exciting technologies that have all coalesced in the past 24 months. By moving quickly to implement the vision of this major, our campus can leverage this momentum and take a significant step toward ensuring our university’s unprecedented leadership role in AR and VR, bringing innumerable benefits to our students, our university, our State, and our society.

1 We can foresee the need for additional academic tracks once the major has been established.
TABLE 1: NUMBER OF CREDITS

<table>
<thead>
<tr>
<th>NUMBER OF CREDITS</th>
<th>TRACK 1</th>
<th>TRACK 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMSC courses</td>
<td>44</td>
<td>3</td>
</tr>
<tr>
<td>MATH courses</td>
<td>15</td>
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<td>ARTT courses</td>
<td>9</td>
<td>45</td>
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<tr>
<td>ARTH/Art theory courses</td>
<td>6</td>
<td>15</td>
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<tr>
<td>IMDM courses</td>
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<td>23</td>
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<tr>
<td>GenEd courses*</td>
<td>31</td>
<td>36</td>
</tr>
<tr>
<td><strong>Total credits</strong></td>
<td><strong>121</strong></td>
<td><strong>122</strong></td>
</tr>
</tbody>
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* Some of the GenEd courses count in more than one category

TABLE 2: NUMBER OF NEW COURSES FOR THE MAJOR

<table>
<thead>
<tr>
<th>NUMBER OF NEW COURSES FOR THE MAJOR</th>
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<tbody>
<tr>
<td>New courses</td>
<td>17</td>
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<tr>
<td>Hybrid courses</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total new courses</strong></td>
<td><strong>21</strong></td>
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</table>
## IMMERSIVE MEDIA DESIGN MAJOR

### TRACK 1: AR/VR

<table>
<thead>
<tr>
<th>SEM</th>
<th>TRACK 1: AR/VR</th>
<th>TRACK 2: EMERGING CREATIVES</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>ENGL 101 (3)</td>
<td>ENGL 101 (3)</td>
</tr>
<tr>
<td></td>
<td>MATH 140 Calculus I (4)</td>
<td>MATH 1xx Math for Creative Computation (3)</td>
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<tr>
<td></td>
<td>ARTT 100 (3)</td>
<td>ARTT 110 (3)</td>
</tr>
<tr>
<td></td>
<td>CMSC 131 (4)</td>
<td>ARTT 2xx (3) (Suggested: ARTH221 or ARTH208K)</td>
</tr>
<tr>
<td></td>
<td>IMDM 101 (UNIV 100 + IMDM content) (1)</td>
<td>ARTT 2xx Post-CMSC 122 visualization emphasis (3)</td>
</tr>
</tbody>
</table>

| 2   | ARTT/ARTH 1xx Digital Media Theory (3) | Gen Ed (3) (Suggested: GEOG170) |
|     | MATH 141 Calculus II (4) | CMSC 216 + 330 hybrid (3) |
|     | CMSC 132 (4) | MATH 240 (4) |
|     | ARTT 110 (3) | ARTT 2xx 3D modeling (3) |
|     | IMDM 102 Research Survey (1) | IMDM 201 Collab. Studio I: Digital Imaging Studio (3) |

| 3   | Gen Ed (3) (Suggested: ENGL298T OR ENGL293) | CMSC 250 + 351 hybrid (3) |
|     | CMSC 201 (3) | ARTT 210 (3) |
|     | ARTT 1xx Upper level Art + Digital Theory (3) | ARTT 3xx (3) |
|     | IMDM 201 Collab. Studio II: 3D Studio I- Modeling for Digital Fabrication (3) | IMDM 202 Collab. Studio II: 3D Studio I- Modeling for Digital Fabrication (3) |
|     | IMDM 203 (Unity course) (3) | IMDM 203 (Unity course) (3) |

| 4   | Gen Ed (3) (Suggested: ARTH221 or ARTH208K) | Gen Ed (3) (Suggested: ARTH221 or ARTH208K) |
|     | ARTT/ARTH 3xx Upper level Art + Digital Theory (3) | CMSC 420 (3) |
|     | CMSC 434 (3) | CMSC 4xx Virtual Reality I (3) |

| 5   | Gen Ed (3) (Suggested: PSYC444, PSYC445 or PSYC489Q) | Gen Ed (3) (Suggested: PSYC444, PSYC445 or PSYC489Q) |
|     | CMSC 425 (3) | Gen Ed (3) |
|     | CMSC 4xx Virtual Reality I (3) | Gen Ed (3) |
|     | CMSC Elective (3) | Gen Ed (3) |
|     | IMDM 302 Collab. Studio IV: Physical Computing Studio II - Making Things Move (3) | IMDM 301 Capstone I (3) |

| 6   | Gen Ed (3) (Suggested: ENGL467 or GEOG498V) | Gen Ed (3) |
|     | CMSC427 (3) | Gen Ed (3) |
|     | CMSC 4xx Virtual Reality II (3) | ARTT4xx Interactive Video + Performance Computing (3) |
|     | CMSC Elective (3) | ARTT 3xx or 4xx elect (3) |
|     | IMDM 401 Capstone I (3) | ARTT 3xx or 4xx elect (3) |

| 7   | Gen Ed (3) | Gen Ed (3) |
|     | CMSC Elective (3) | Gen Ed (3) |
|     | CMSC Elective (3) | ARTT/ARTH 4xx Advanced Media Theory (3) |
|     | IMDM 402 Capstone II (3) | IMDM 401 Capstone I (3) |

| 8   | Gen Ed (3) | Gen Ed (3) |
|     | Gen Ed (3) | ARTT/ARTH 4xx Advanced Media Theory (3) |
|     | CMSC Elective (3) | IMDM 402 Capstone II (3) |
|     | CMSC Elective (3) | IMDM 401 Capstone I (3) |

Total: 121 credits | Total: 122 credits
** Denotes new or altered courses

**IMDM COURSES**

**IMDM 101: Research survey**
Credits: 1
Faculty members with related research make presentations about their work to show the range of possible projects and avenues for these collaborations.

**IMDM 102: Choosing a project**
Credits: 1
Modeled after Gemstone, students make suggestions, gradually narrow down and then commit the projects they want to work on for the following year.

**IMDM 2xx: Unity course**
Credits: 3
Software course with design and coding components. This course will teach modeling system sand lighting.

**IMDM 2xx: Collaborative Studio**
Credits: 3
Students work in teams on collaborative projects decided upon the semester 2. Team taught by faculty from two different departments, such as ARTT and CMSC.

**IMDM 3xx(?) Systems course**
Credits: 3
Systems course to understand virtual memory, getting a system to perform optimally, and understanding of operating systems.
(Need to add to schedule)

IMDM 301 and beyond studios:
Theory, collaboration, making and exploration.
The direction and subject matter is determined by the cross-disciplinary team teaching each course.
Each course will be taught by a different pairing of faculty.

3 credits of internship required for all students between Junior and Senior year

IMDM Design Fundamentals: combining 2D & 3D art studio; more holistic approach to design with the use of technology

A fundamental art studio course that reflects contemporary practice
ART HISTORY COURSES

ARTH221: Color: Art, Science, and Culture
Credits: 3
An interdisciplinary exploration of the intersections of art, science, and culture. Using research on human vision, neurobiology, and cognitive psychology, examines how vision works, why we see color, and how we respond to color. Investigates the cultural significance of color: how artists across time and cultures have had access to and used color; how cultures have created specific language to describe color; and how cultures have imbued color with profane, sacred, and/or symbolic meanings.

**ARTH 208K: Informing our cultural commons in the wired age
Credits: 3
Who tells the stories of and in our cultural spaces? Who should? And how does the advent of digital technologies, especially augmented and virtual reality, change what stories we tell about ourselves and who does the telling?

ART STUDIO COURSES

ARTT100: Two-Dimensional Design Fundamentals
Credits: 3
Principles and elements of two-dimensional design. Introduction to visual communication.

ARTT110: Elements of Drawing I
Credits: 3
Fundamental concepts, media, and processes of drawing. Emphasis on observation and representation in combination with individual expression. Subject matter includes still life, human figure, nature, the built environment, and conceptual projects.

ARTT200: Three-Dimensional Art Fundamentals
Credits: 3
Prerequisite: ARTT100 and ARTT110.
Fundamental concepts of three-dimensional form and space examined through the manipulation and organization of various materials.

ARTT210: Elements of Drawing II
Credits: 3
Prerequisite: ARTT110.
Continuation of ARTT110 with additional emphasis on color, figure drawing, and contemporary issues.

ARTT255: Introduction to Digital Art and Design Processes
Credits: 3
Prerequisite: ARTT100 and ARTT110. Credit only granted for: ARTT255 or ARTT354. Formerly: ARTT354.
Introduction to basic software and principles of digital imaging, and how they are applied to art and design. Topics covered: Digital image construction and manipulation, Vector-Based digital techniques layout, typography, etc., time-based digital techniques (video and audio composition and manipulation), and basic interactivity (web-design). Digital media used to explore visual principles established in ARTT100.

*ARTT256: Introduction to Digital Art and Design Processes
Credits: 3
ARTT255 with more 3D modeling and/or coding reveal digital media used to explore visual principles established in ARTT100.

**ARTT 2xx(?) 3D Digital Design
Credits: 3
Digital modeling building. 3D software course and physical output. (Need to add to schedule)

CMSC COURSES

**CMSC pre-122: Introduction to Computer Science
Credits: 3
A new course that will provide an introduction to Computer Science and computer programming targeted to students with a broad diversity in backgrounds. Students will use a problem-driven approach to design and build interactive software systems. The course also includes an introduction to a wide variety of issues relating to software, including design, problem-solving, development processes, and broader issues such as security, performance, and ethics.)

CMSC122: Introduction to Computer Programming via the Web
Credits: 3
GenEd: DSSP
Restriction: Must not have completed any courses from CMSC131-499 course range; and must not be concurrently enrolled in CMSC131. Credit only granted for: CMSC122 or CMSC198N. Formerly: CMSC198N.
Introduction to computer programming in the context of developing full featured dynamic web sites. Uses a problem solving approach to teach basics of program design and implementation using JavaScript; relates these skills to creation of dynamic web sites; then explores both the potential and limits of web-based information sources for use in research. Intended to help relate a student’s major to these emerging technologies.

CMSC131: Object-Oriented Programming I
Credits: 4
Corequisite: MATH140; and permission of CMNS-Computer Science department.
Introduction to programming and computer science. Emphasizes understanding and implementation of applications using object-oriented techniques. Develops skills such as program design and testing as well
as implementation of programs using a graphical IDE. Programming done in Java.
For CMSC majors only.

**CMSC132: Object-Oriented Programming II**
Credits: 4
Prerequisite: Minimum grade of C- in CMSC131; or must have earned a score of 5 on the AP Java exam. Or permission of the department based on satisfactory performance on the department placement exam; and minimum grade of C- in MATH140; and permission of CMNS-Computer Science department.
Introduction to use of computers to solve problems using software engineering principles. Design, build, test, and debug medium-size software systems and learn to use relevant tools. Use object-oriented methods to create effective and efficient problem solutions. Use and implement application programming interfaces (APIs). Programming done in Java.

**CMSC 216 + 330 Hybrid: Organization of Computer Systems and Languages**
Credits: 3
Prerequisite: Minimum grade of C- in CMSC250; and permission of CMNS-Computer Science department.
**New course** Modern computer architecture and its interaction with software. Interactions between user programs and the operating system. The semantics of programming languages and their run-time organization. Programming language models, including procedural (e.g., C, Pascal), functional (e.g., ML, LISP), rule-based (e.g., Prolog), and object-oriented (e.g., C++, Smalltalk). Run-time structures, including dynamic versus static scope rules and static and dynamic storage systems.

**CMSC250 + 351 Hybrid: Discrete Structures and Algorithms**
Credits: 4
Prerequisite: Minimum grade of C- in CMSC131; and minimum grade of C- in MATH141.
**New course** Fundamental mathematical concepts related to computer science, including sets, relations, and functions. Introduction to computational structures, such as graphs and trees. Elementary algorithms related to sorting, graphs and trees, and combinatorics. Analysis of algorithm efficiency through asymptotics, recurrences, and summations.

**CMSC417: Computer Networks**
Credits: 3
Prerequisite: Minimum grade of C- in CMSC351 and CMSC330; and permission of CMNS-Computer Science department. Or must be in the (Computer Science (Doctoral), Computer Science (Master's)) program.
Computer networks and architectures. The OSI model including discussion and examples of various network layers. A general introduction to existing network protocols. Communication protocol specification, analysis, and testing.
CMSC420: Data Structures
Credits: 3
Prerequisite: Minimum grade of C- in CMSC351 and CMSC330; and permission of CMNS-Computer Science department. Or must be in the (Computer Science (Doctoral), Computer Science (Master's)) program.
Description, properties, and storage allocation of data structures including lists and trees. Algorithms for manipulating structures. Applications from areas such as data processing, information retrieval, symbol manipulation, and operating systems.

CMSC421: Introduction to Artificial Intelligence
Credits: 3
Prerequisite: Minimum grade of C- in CMSC351 and CMSC330; and permission of CMNS-Computer Science department. Or must be in the (Computer Science (Doctoral), Computer Science (Master's)) program.
Areas and issues in artificial intelligence, including search, inference, knowledge representation, learning, vision, natural languages, expert systems, robotics. Implementation and application of programming languages (e.g. LISP, PROLOG, SMALLTALK), programming techniques (e.g. pattern matching, discrimination networks) and control structures (e.g. agendas, data dependencies).

CMSC425: Game Programming
Credits: 3
Prerequisite: Minimum grade of C- in CMSC420.
An introduction to the principles and practice of computer game programming and design. This includes an introduction to game hardware and systems, the principles of game design, object and terrain modeling, game physics, artificial intelligence for games, networking for games, rendering and animation, and aural rendering. Course topics are reinforced through the design and implementation of a working computer game.

CMSC426: Image Processing
Credits: 3
Prerequisite: Minimum grade of C- in CMSC420; or must be in the (Computer Science (Doctoral), Computer Science (Master's)) program. Restriction: Permission of CMNS-Computer Science department.
An introduction to basic techniques of analysis and manipulation of pictorial data by computer. Image input/output devices, image processing software, enhancement, segmentation, property measurement, Fourier analysis. Computer encoding, processing, and analysis of curves.

CMSC427: Computer Graphics
Credits: 3
Prerequisite: MATH240; and minimum grade of C- in CMSC420; and permission of CMNS-Computer Science department. Or must be in the (Computer Science (Doctoral), Computer Science (Master's)) program.
An introduction to the principles of computer graphics. Includes an introduction to graphics displays and
systems. Introduction to the mathematics of affine and projective transformations, perspective, curve and surface modeling, algorithms for hidden-surface removal, color models, methods for modeling illumination, shading, and reflection.

**CMSC434: Introduction to Human-Computer Interaction**  
Credits: 3  
Prerequisite: Minimum grade of C- in CMSC330 and CMSC351; and PSYC100; and permission of CMNS-Computer Science department. Or must be in the (Computer Science (Doctoral), Computer Science (Master’s)) program.  
Assess usability by quantitative and qualitative methods. Conduct task analyses, usability tests, expert reviews, and continuing assessments of working products by interviews, surveys, and logging. Apply design processes and guidelines to develop professional quality user interfaces. Build low-fidelity paper mockups, and a high-fidelity prototype using contemporary tools such as graphic editors and a graphical programming environment (e.g., Visual Basic and Java).

**CMSC435: Software Engineering**  
Credits: 3  
Prerequisite: 1 course with a minimum grade of C- from (CMSC412, CMSC417, CMSC420, CMSC430, CMSC433); and permission of CMNS-Computer Science department. Or must be in the (Computer Science (Doctoral), Computer Science (Master’s)) program.  
State-of-the-art techniques in software design and development. Laboratory experience in applying the techniques covered. Structured design, structured programming, top-down design and development, segmentation and modularization techniques, iterative enhancement, design and code inspection techniques, correctness, and chief-programmer teams. The development of a large software project.

**CMSC436: Programming Handheld Systems**  
Credits: 3  
Prerequisite: Minimum grade of C- in CMSC330 and CMSC351; or must be in the (Computer Science (Doctoral), Computer Science (Master’s)) program. Restriction: Permission of CMNS-Computer Science department.  
Fundamental principles and concepts that underlie the programming of handheld systems, such as mobile phones, personal digital assistants, and tablet computers. Particular emphasis will be placed on concepts such as limited display size, power, memory and CPU speed; and new input modalities, where handheld systems differ substantially from non-handheld systems, and thus require special programming tools and approaches. Students will apply these concepts and principles in the context of an existing handset programming platform.

**CMSC451: Design and Analysis of Computer Algorithms**  
Credits: 3  
Prerequisite: Minimum grade of C- in CMSC351; and permission of CMNS-Computer Science department. Or must be in the (Computer Science (Doctoral), Computer Science (Master’s)) program.  
Fundamental techniques for designing efficient computer algorithms, proving their correctness, and
analyzing their complexity. General topics include sorting, selection, graph algorithms, and basic algorithm design paradigms (such as divide-and-conquer, dynamic programming and greedy algorithms), lower bounds and NP-completeness.

ENGL COURSES

**ENGL289T: Representing Technology/Technologies of Representation: Techno Monstrosities**
Credits: 3
How do we initially understand new technologies, and how do these modern instrumentalities in turn represent us? This course seeks to address this double-edged question by looking at a series of nineteenth-century American, French, German, and British novels and stories from Frankenstein (1818) to Dracula (1897) featuring recently introduced media and inventions such as photographs, phonographs, automata, and motion pictures that are themselves (like works of literature) concerned with reproducing “reality,” including recording various aspects of the human body and human consciousness.

**ENGL293: Writing in the Wireless World**
Credits: 3
Recommended: ENGL101. Credit only granted for: ENGL278Z or ENGL293. Formerly: ENGL278Z.
A hands-on exploration of writing at the intersection of technology and rhetoric. Students will learn to read, analyze, and compose the kind of multimodal documents (combining text, image, and sound) that constitute communication in our digital world.

**ENGL467: Computer and Text**
Credits: 3
Prerequisite: One English course in literature; or permission of ARHU-English department.
Examines electronic literature and other aspects of digital textuality. Topics may include interactive fiction, hypertext, image and sound works, literary games and simulations. Emphasis on critical and theoretical approaches rather than design or programming.

**ENGL488A: Topics in Advanced Writing; Web Authoring**
Credits: 3
(No course description listed.)

GEOGRAPHY COURSES

**GEOG170: Introduction to Methods of Geospatial Intelligence and Analysis**
Credits: 3
Introduction to technical methods used in gathering, analyzing, and presenting geospatial information, addressing the needs of geospatial analysis, such as environmental monitoring, situational awareness, disaster management, and human systems. Topics include basics of locational reference systems, map projections, satellite and airborne remote sensing, global positioning systems, geographic information
systems, cartography, and introductory statistics and probability. The course is a gateway to more advanced technical classes in geoinformatics.

CORE: MS  GenEd: DSNS

GEOG498V: Mobile GIS
Credits: 3
Introduction to the science, methods, and application domains of mobile Geographic Information Systems. Topics include positioning and localization systems, human-computer interaction on mobile platforms, and application development for use in the behavioral and social sciences.

MATH COURSES

**ARTT1xx: Math for Creative Computation
Credits: 3
Mathematical equations and basic mathematical knowledge necessary for creative computation.

MATH110: Elementary Mathematical Models
Credits: 3
Prerequisite: Must have math eligibility of MATH110 or higher; and math eligibility is based on Math Placement Exam or successful completion of MATH003 with appropriate eligibility. Restriction: Not open to students majoring in mathematics, engineering, business, life sciences, and the physical sciences; and must not have completed MATH220, MATH130, or MATH140; and must not have completed any MATH or STAT course with a prerequisite of MATH140 or MATH130 or MATH220. Credit only granted for: MATH110, MATH112, or MATH113.
Topics include simple and compound interest; recursion for computing balances; installment loans and amortization; approximating data by linear models; analysis of applications to real-world collections of data; probability; conditional probability; independence; expected value; graphing and analysis of systems of inequalities; linear programming and applications.

MATH115: Precalculus
Credits: 3
Prerequisite: Must have math eligibility of MATH115 or higher; and math eligibility is based on the Math Placement Exam or the successful completion of MATH003 with appropriate eligibility. Or MATH113. Restriction: Must not have completed MATH140; and must not have completed any MATH or STAT course with a prerequisite of MATH140. Credit only granted for: Students who have credits for MATH115 may not also receive credits for MATH112 or MATH113.
Preparation for MATH220, MATH130 or MATH140. Elementary functions and graphs: polynomials, rational functions, exponential and logarithmic functions, trigonometric functions. Algebraic techniques preparatory for calculus.
All sections will require the use of a TI graphics calculator. Instructor will use a TI-83 or a TI-83+ calculator.
MATH140: Calculus I
Credits: 4
Prerequisite: Minimum grade of C- in MATH115. Or must have math eligibility of MATH140 or higher; and math eligibility is based on the Math Placement Test. Credit only granted for: MATH130, MATH220, or MATH140.
Introduction to calculus, including functions, limits, continuity, derivatives and applications of the derivative, sketching of graphs of functions, definite and indefinite integrals, and calculation of area. The course is especially recommended for science, engineering and mathematics majors.
All sections will require the use of a TI graphics calculator. Instructor will use a TI-83, TI-83+, or TI-86 calculator. Emphasis on student interaction in groups, including team approach to solving calculus based problems. There will be 3 one-hour lectures and 2 eighty-minute workshops each week with enhanced assistance and support for students.

MATH141: Calculus II
Credits: 4
Prerequisite: Minimum grade of C- in MATH140. Or minimum grade of B- in MATH130; and permission of CMNS-Mathematics department. Credit only granted for: MATH131, MATH141, or MATH221.
Continuation of MATH140, including techniques of integration, improper integrals, applications of integration (such as volumes, work, arc length, moments), inverse functions, exponential and logarithmic functions, sequences and series.
All sections will require the use of a TI graphics calculator. Instructor will use a TI-83, TI-83+, or TI-86 calculator.

MATH240: Introduction to Linear Algebra
Credits: 4
Prerequisite: Minimum grade of C- in MATH131; or MATH141. Credit only granted for: MATH240, MATH341, or MATH461.
Basic concepts of linear algebra: vector spaces, applications to line and plane geometry, linear equations and matrices, similar matrices, linear transformations, eigenvalues, determinants and quadratic forms.

MATH431: Geometry for Computer Graphics
Credits: 3
Prerequisite: MATH461, MATH240, or MATH341.
Topics from projective geometry and transformation geometry, emphasizing the two-dimensional representation of three-dimensional objects and objects moving about in the plane and space. The emphasis will be on formulas and algorithms of immediate use in computer graphics.

PSYCHOLOGY COURSES

PSYC444: Cyberpsychology: The Psychology of Human/Computer Interactions
Credits: 3
Explores traditional psychological processes in the rapidly changing world of computer and internet
technologies. Students will address how the use of computers impacts many of the major topics in psychology.

**PSYC445: The Psychology of Video Games and Entertainment**

Credits: 3

An exploration of the diverse elements and theories in the psychology of video games and entertainment. The history and taxonomy of video games, cognitive and affective elements, virtual reality and social presence, video game violence, and educational and ethical issues will be covered.

**PSYC489Q: Advanced Special Topics in Psychology: Social Media and Social Computing**

Credits: 3

Social Media and social computing is the intersection of psychology and computer science. This course will survey social media sites (e.g., Facebook, Twitter, and Snapchat), the psychological issues and behaviors that manifest themselves on the media (e.g., anonymity, dissociation, social equalization, and cyber-bullying), and the analysis of social media data.