Bachelor of Science in Systems Engineering

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If you have a need for additional information, please contact us:
Phone: (703) 993-1670
Email: seor@gmu.edu
Web: http://seor.gmu.edu

The Systems Engineering and Operations Research Department (SEOR)
is located in Room 2100, Nguyen Engineering Building

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1. Introduction

The engineering problems of the future are systems problems. As we compare our world today with the world our grandparents knew, we see a striking increase in the complexity of the human-made systems that pervade our lives. For example, today's automobiles and airplanes are far more complex than those of a generation ago, and are part of a vastly more complex and interconnected regional, national, and international transportation system. As another example is the global financial system. Could our grandparents have imagined inserting a small card into a machine in Paris to withdraw cash from a bank account in Virginia? Our quality of life depends on our ability to design, develop and maintain systems that function smoothly and serve our needs. As the systems around us grow more complex, the need grows for engineers who understand not just the pieces, but how they interact to form an organic whole.

Systems engineers define, design, develop and integrate, and test systems. Whereas other engineering disciplines concentrate on individual aspects of a system (electronics, ergonomics, software, etc.), systems engineers focus on the system as a whole. They do more than simply analyze technical aspects of how the system performs. Systems engineers work with users and other stakeholders to ensure that the system meets the needs of its users and interacts appropriately with other systems. They analyze cost and performance of systems. They plan for the entire lifecycle of a system, from the time a need is first identified, through system design, development, operation, maintenance, and disposal. They test and evaluate systems. They use the results of evaluation not just to improve individual systems, but also to improve their organizations' systems engineering processes.

The mission of the undergraduate program in Systems Engineering at George Mason University is to equip students with the ability to participate productively in the many professional activities associated with the engineering of a system that satisfies the needs of clients over the lifecycle of the system. These activities include the brokering of information and knowledge between clients and implementation specialists to assure that a system is properly defined, developed, and deployed. The term system is interpreted broadly, examples being information systems, network and communications systems, defense systems, health delivery systems, transportation systems, manufacturing systems and corporate processes. Our nationally recognized program in systems engineering prepares students for immediate employment as well as for a lifetime of learning. Our program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

Our program objective is to graduate students who will

1. Apply critical thinking, quantitative methods, systems thinking, and principles of engineering to the engineering of contemporary and future systems.
2. Apply systems engineering methods, processes, models and tools to the engineering of contemporary and future systems.
3. Work successfully, professionally, and ethically as members and leaders of multi-disciplinary teams.

2. Degree Requirements

The program leading to the Bachelor of Science in Systems Engineering (BSSE) prepares students for a professional career in systems engineering. Our educational program reflects the systems engineer's unique perspective that considers all aspects of a system throughout the entire lifetime of that system. The systems engineering program at Mason is interdisciplinary, drawing from engineering, computer science, operations research, psychology and economics. The core systems engineering courses tie together these diverse threads to provide a global understanding of how individual engineering disciplines fit into the development of complex, large scale systems. Students gain depth in a technical area by selecting a sequence of technical electives that constitute a *specialization area* (Aviation Systems, Bioengineering, Control Systems, Computer Network Systems, Data Analytics, Financial Engineering, Mechanical Engineering, Operations Research and Software-Intensive Systems). A year-long senior-design project provides hands-on experience in applying various systems engineering methods and tools. Students may also elect to obtain an accelerated B.S./M.S. in Systems Engineering in five years with careful planning. This is described further in later sections.

To earn the Bachelor of Science degree, students must satisfy all baccalaureate degree requirements as described in the George Mason University Catalog.[1] These requirements include:

- Completion of at least 123 credits that count towards graduation including at least 45 credits of upper-division level courses (numbered 300 or above), and fulfillment of all degree requirements.
- Mason Core requirements ensuring competency in written and oral communication, information technology, fine arts, quantitative reasoning, literature, western civilization, natural and social sciences, global understanding, and synthesis.
  - Mason's natural science requirement may be satisfied by CHEM 211&213 or CHEM 251 or PHYS 262&263 or BIOL 213. The lecture and laboratory must both belong to the same subject (e.g., PHYS 262&263 satisfy the requirement, but PHYS 262 & CHEM 213 do not). Students who take the Bioengineering specialization are strongly encouraged to take BIOL 213 (BIOL 213 has CHEM 211 as a corequisite, but this requirement will be waived for BSSE students).
  - To satisfy the Mason Core requirement in global understanding, students are encouraged to take SYST 202, Engineering Systems in a Complex World.
  - Mason's synthesis requirement for systems engineering majors is satisfied by successful completion of SYST 495 - Senior Design Project II. SYST 495 is also designated as a capstone course for the BSSE major. Students who do not pass SYST 495 with a grade of C or better must retake both SYST 490 and SYST 495.
- The residency requirement that one-fourth of the total semester hours presented on the degree application must be completed at the university and must include at least 12 semester hours of courses at the 300 level or above
- The academic requirement of a GPA of at least 2.0.
- A grade of C or better in ENGH 100 or 101, and ENGH 302.

In addition, to earn the Bachelor of Science degree in Systems Engineering, students must pass the following classes with a grade of C or better (this list includes most of the technical classes in the major):

- CS 112, MATH 113, 114, 213, PHYS 160. (Students must pass these classes with a grade of C or better to satisfy pre-requisites for later courses.)
- MATH 203, 214, PHYS 260, STAT 344, 354, CS 211, SYST 101, 210, 220, 221, 320, 330, 335, 371, 395, 470, 473, 489, 490, 495, OR 441, 442, the three technical electives. (Students who have ***at most*** one C- in these courses may petition to receive a one-time waiver. Waiver requests must be submitted in writing to the Department Chair and must be approved by the Department Chair.)

Notes: Students must pass MATH 105 with a grade of C (or pass the Math Placement Test) to get into MATH 113. MATH 123-124 (2 courses, 6 credits total) is equivalent to MATH 113. A student must have a C or better in both MATH 123-124 in order to take CS 112. This two-semester sequence is designed for students with a limited math background who desire careers in the sciences. Students who successfully complete MATH 123-124 are considered the same as having successfully completed MATH 113.

3. Advising

All systems engineering students are assigned a faculty advisor. Students should meet with their advisors to determine an appropriate set of classes to take each semester. Students must also complete an approved plan of study, which constitutes a proposed schedule and learning plan for completing the degree program. The last page of this pamphlet contains a blank plan of study to be filled out by the student. The following requirements apply to the plan of study:

[1] This BSSE brochure serves as guidance in advising students, but is not an official document for specifying graduation requirements. In the event of disagreement between the requirements in this document and the George Mason University Catalog, the catalog is the final arbiter.

- The plan of study must be approved and signed by the student's advisor. Once the plan is approved by the advisor, the plan must then be signed by the SEOR Chair. The SEOR Chair has the final say regarding whether or not the plan of study is approved. The plan of study is then placed on file in the department office.
- The plan of study must be updated and signed at least once per year. This applies even if the updated plan of study is identical to the previous plan. This requirement is enforced in SYST 101, 210, 220, and 330; students in these courses who do not have a current plan of study on file receive an incomplete grade at the end of the semester; final letter grades are given once a current plan of study is filed.
- A student can change his or her plan of study at any time. However, all changes must be re-approved by the student's advisor and by the Department Chair via a signature on the plan of study. ***Approval for a new plan of study should be obtained before taking classes from the new plan. Without prior department approval, there is no guarantee that classes taken outside of the approved plan of study will count toward the degree.***

Students should finalize their class schedules early. Classes cannot be added after the first week of classes. Also, students must attend the first meeting of any lab in which they are enrolled or they may be dropped from the class – even if the class is composed of a lecture in addition to the lab.

The following policies apply to repeated courses: Students may attempt an undergraduate course taught by the Volgenau School of Engineering (VSE) twice. A third attempt requires approval of the department offering the course. This policy does not apply to STAT 250, which follows the normal university policy for repeating undergraduate courses. No math, science or VSE course, required for the major, may be attempted more than three times. Those students who do not successfully complete such a course within three attempts will be terminated from the major. For more information, see the "Termination from the Major" section under Academic Policies in the Mason catalog. Within the SEOR major, if a student fails a technical elective course (either offered by SEOR or another department) three times then the student will be asked to take another technical elective sequence. In this case the student will not be terminated from the major. The SEOR department will not consider withdrawn "W" courses as an attempt toward the count of three. The UG committee in the SEOR department will discuss any such termination cases and provide recommendation to the Chair.

4. Specialization Areas

The Systems Engineering program requires nine semester hours of technical electives. Student must select one of the following specialization areas: Aviation Systems, Bioengineering, Computer Network Systems, Control Systems, Data Analytics, Financial Engineering, Mechanical Engineering, Operations Research, or Software Intensive Systems. ***All specializations and the corresponding plan of study must be approved by the student's advisor.*** See Section 12 for information on how to fit the three courses into your overall schedule and sequence of classes.

Technical electives are composed of 300- and 400- level courses from VSE. 200- level courses are only included if they are prerequisites for other 300- or 400- level technical electives or if they are needed for the FE/EIT exam.

Aviation Systems

The aviation systems specialization prepares students for employment in the air transportation and space systems industry. This specialization provides fundamental background in the structure and operation of the air transportation system and the air traffic control system, as well as fundamental principles underlying the operation of networked systems. Students in this specialization must take the following three courses (9 credits)

- SYST 420 – Network Analysis
- SYST 460 – Introduction to Air Traffic Control
- SYST 461 – Air Transportation System Engineering

Bioengineering

Bioengineering is an interdisciplinary field involving the application of engineering concepts and tools to solve problems in biology and medicine. The demand for bioengineers is growing with increasing costs of healthcare and the impact of

novel technology to fundamental understanding in biosciences. Students in this specialization must take BENG 313 and two courses from BENG 304, 406, and 420 (9 credits)

- BENG 313 – Physiology for Engineers (required),

Two courses from:

- BENG 304 – Modeling and Control of Physiological Systems
- BENG 406 – Biomechanics
- BENG 420 – Bioinformatics for Engineers

Notes:

- *Students are strongly encouraged to take BIOL 213 to satisfy their natural science requirement. BIOL 213 has CHEM 211 as a corequisite, but this requirement will be waived for BSSE students.*
- *CHEM 211-3 can be used as a substitute for BIOL 213 as a pre-requisite to take BENG 313.*
- *SYST 220/320 can be used as a substitute whenever BENG 220/320 is needed as a pre-requisite.*

Computer Network Systems

This specialization provides students with basic technical background in areas important to computer networks and communications systems. The courses prepare the BS/SE graduate to obtain immediate employment in the telecommunications industry in the areas of product development, consulting, customer/stakeholder modeling and analysis, or network analysis. Students are also prepared for employment in network administration and information technology departments of corporations or agencies. Students in must take the following three courses (9 credits)

- TCOM 500 – Modern Telecommunications
- SYST 420 – Network Analysis
- ECE 465 – Computer Networking Protocols

Note: TCOM 500 is a graduate class with a prerequisite of "graduate standing." Students must obtain written permission from the SEOR department chair to take this course before beginning this specialization sequence.

Control Systems

Control systems manage, direct, or regulate the behavior of other devices or systems. Examples include regulation of heating and cooling systems in response to ambient temperature or management of medical devices to maintain specified levels of a drug in a patient's bloodstream. The courses in this sequence provide fundamental technical principles of control systems. Students in this specialization are prepared to participate in the design, manufacture and testing of systems that include a control component. Students must take the following three courses (9 credits):

- ECE 201 – Introduction to Signal Analysis
- ECE 220 – Signals and Systems I
- SYST 421 – Classical Systems and Control Theory

Note: Students must attend the first meeting of any lab in which they are enrolled or they may be dropped from the class (even if the class is composed of a lecture in addition to the lab). This applies to ECE 201 and ECE 220 which both have labs. ECE 201 has ECE 101 as a pre-requisite; BSSE students will get an override for ECE 101.

Data Analytics

Data analytics is the process of acquiring, extracting, integrating, transforming, and modeling data with the goal of deriving useful information. It is becoming an important quantitative methodology in a wide variety of applications. The need for data analytics is due to the massive accumulation of "Big Data" in all industries including (but not limited to) healthcare, finance, government, and cyber defense. Students in this specialization must take the following three courses (9 credits)

- SYST 468 – Applied Predictive Analytics
- IT 214 – Database Fundamentals
- STAT 463 – Introduction to Exploratory Data Analysis or

SYST 438 – Analytics for Financial Engineering and Econometrics

Note: STAT 463 is currently offered in alternate years during the spring.

Financial Engineering

Financial Engineering is an interdisciplinary field which relies on mathematical finance, numerical methods, and computer simulations to make trading, hedging, and investment decisions, as well as facilitating the risk management of those decisions. Students in this specialization must take the following three courses (9 credits)

- SYST 438 – Analytics for Financial Engineering and Econometrics
- STAT 463 – Introduction to Exploratory Data Analysis, or
  STAT 455 – Experimental Design, or
  SYST 468 – Applied Predictive Analytics
- SYST 488 – Financial Systems Engineering

Note: STAT 463 and STAT 455 are currently offered in alternate years during the spring.

Mechanical Engineering

The Mechanical Engineering specialization provides basic knowledge of mechanical engineering to prepare students in the design of mechanical elements or the understanding of fluid dynamics and heat transfer. The courses in this specialization sequence provide background in a) the design of mechanical elements and their behavior in response to loads, b) fluid systems that include conservation laws of fluid flow, and c) thermal systems including thermal radiation, design of gas and vapor power cycles, refrigeration and air conditioning, and propulsion systems. Students in this specialization must choose between one of the following two tracks (9 credits)1

Mechanical Design

- ME 211 – Statics, or
  CEIE 210 - Statics
- ME 212 – Solid Mechanics, or
  CEIE 310 Mechanics of Materials
- ME 341 – Design of Mechanical Elements, or
  ME 231 - Dynamics

Notes:

- *CEIE 210 and CEIE 310 are both 3-unit classes with 2 units of lecture (2 hours of class time) and 1 unit of recitation (3 hours of class time). Thus, each class has 5 hours of class time per week.*
- *CEIE 210 and CEIE 310 are offered at NVCC via the courses EGR-240 and EGR-246, respectively. In addition, EGR-245 at NVCC will be accepted for ME 231.*

Thermal Fluids

- ME 221 – Thermodynamics
- ME 322 – Fluid Mechanics
- ME 323 – Heat Transfer, or
  ME 342 – Design of Thermal Systems

Operations Research

The operations research specialization provides fundamental technical background for students who are interested in examining key feasibility and trade off decisions associated with any type of system, whether physical, organizational, or political. Students completing this track are prepared to find employment in the systems engineering or operations research division of a corporation or agency. Students must take the following three courses (9 credits):

- OR 481 – Numerical Methods
- SYST 420 – Network Analysis

- SYST 468 – Applied Predictive Analytics

Software-Intensive Systems

Software systems are pervasive in our society. This specialization prepares students for careers in design, implementation and maintenance of computer software systems. Students completing this track are prepared for immediate employment as a computer programmer, systems analyst, software requirements engineer, or software test and maintenance engineer. Students in this specialization area may choose to pursue a minor in Computer Science. Please see the Computer Science department for more information on the minor. Students in this specialization must take the following three courses (9 credits):

- CS 310 – Data Structures
- CS 321 – Software Engineering
- CS 332 – Object-Oriented Software Design and Implementation

Note: CS 105 (Computer Ethics and Society) is a corequisite for CS 310. BSSE majors should complete an override form from the CS department indicating that they do not have to take CS 105 in order to take CS 310.

Minors and Certificates in Related Disciplines

There are several interdisciplinary minors and certificate programs available to students. Of particular interest to Systems Engineering students are the minors listed below. Note that the following requirements apply to all minors (from Mason catalog): *At least 8 credits of the minor must be applied only to that minor and may not be used to fulfill requirements of the student's major, concentration, an undergraduate certificate, or another minor. Students must complete at least 6 credits in their minor at Mason and achieve a minimum 2.00 GPA in courses applied to the minor.*

- The minor in Business Administration can be completed with the addition of 15 credit hours.
- The minor in Mathematics can be completed with the addition of 9 credit hours.
- The minor in Computer Science can be completed by students in the Software Intensive Systems specialization with at least 8 additional credits including a 1 credit course on computer ethics.
- The minor in Data Analysis can be completed by students in the System Modeling and Performance specialization with at least 8 additional credits.

Minor in Systems Engineering and Operations Research

The minor in SEOR is especially appropriate for students in ECE, CEIE, AIT, CS, and MATH. *The minor in Systems Engineering and Operations Research is not available for students receiving a B.S. in Systems Engineering*. The minor consists of 15 credit hours of coursework, including:

- Two required courses: Either SYST 101 or SYST 210, and SYST 473.
- Three electives from: SYST 210, SYST 220/221, SYST 320, SYST 330, SYST 371, SYST 460, SYST 461, SYST 468, either SYST 469 or SYST 470, OR 335, either OR 441 or MATH 441, either OR 442 or MATH 442, either OR 481 or MATH 446.

Note: If a student takes both SYST 101 and SYST 210, then SYST 210 counts as one of the three electives. If a student takes SYST 210 but not SYST 101, then SYST 210 counts as a required course but not as an elective course.

The following are feasible elective courses for each of these majors:

- ECE: OR/SYST 335, SYST 371, OR 441, OR 442, OR 481, SYST 460, SYST 461
- BENG: OR/SYST 335, SYST 371, OR 441, OR 442, OR 481, SYST 460, SYST 461
- CEIE: SYST 371, SYST 470, OR 442, SYST 460, SYST 461
- AIT: SYST 371, SYST 469, SYST 460, SYST 461
- CS: OR/SYST 335, SYST 371, SYST 470, OR 441, OR 442, OR 481, SYST 460, SYST 461
- MATH: SYST 371, OR 441, OR 442, OR 481, SYST 460, SYST 461

Students should pay careful attention to the prerequisites when selecting courses. ECE and BENG students with CS 222 are eligible to take SYST/OR 335 as an elective.

Minor in Aviation Flight Training and Management

This minor provides students with a unique opportunity to earn a pilot's license and gain expertise in various aspects of aviation management. Courses prepare students to take the required government licensing exams such as the Federal Aviation Administration (FAA) Knowledge Test and FAA Flight Tests. The minor consists of 15 credit hours of coursework, including:

- Three required courses: SYST 460, SYST 462* and SYST 463*
  *Note: Lab fees to cover flight training costs apply
- One additional course from: SYST 371, SYST 461, MIS 303, MBUS 301, MBUS 305
- One additional course from: SYST 469 or SYST 470, PSYC 317, PSYC 333, HIST 378

For further information contact the Systems Engineering Department at http://seor.gmu.edu/

5. Accelerated B.S./M.S. Degree in Systems Engineering

Qualified undergraduate students may apply for a five-year accelerated BS/MS program leading to a Bachelor of Science in an engineering discipline and an MSSE degree. The accelerated BS/MS program can be completed in 147 credit hours. The following conditions apply:

- Applicants must be Mason undergraduate students majoring in VSE.
- Applicants must have an overall GPA of at least 3.30 and must have completed all their MATH and PHYS requirements. Criteria for admission into the accelerated BS/MS program are identical to criteria for admission into the MSSE program, except that students do not need to have completed their BS degree.
- Students may apply for the accelerated BS/MS program during a semester after which they will have completed 90 or more credit hours applicable to their degree. Note that undergraduates with a GPA of at least 3.6 can also apply to take 2 graduate courses before being accepted into the accelerated BS/MS program, and these courses can be counted toward the program even if taken before the student is accepted.

Students must complete all requirements for the BS degree in their chosen major. Students in the accelerated BS/MS program may apply to have the BS degree from the appropriate VSE program conferred during the semester during which they expect to complete their BS requirements. The MSSE degree is granted upon completion of all requirements for the MSSE degree.

Up to two courses (six credit hours) of masters level courses may be applied to both the undergraduate and graduate degrees. These two courses may be chosen from the list of graduate courses in the following table. For BSSE majors, these graduate courses replace the corresponding undergraduate courses listed in the table. The undergraduate version of these courses may *not* be applied toward the MSSE degree.

Graduate Course	Undergraduate Course	Comment
SYST 521	SYST 420	Credit may not be received for both SYST420 and SYST521
SYST 573	SYST 473	Credit may not be received for both SYST573 and SYST473
OR 541	OR 441	Credit may not be received for both OR 541 and OR 441
OR 542	OR 442	Credit may not be received for both OR 542 and OR 442

Systems engineering majors in the accelerated BS/MS program may take a technical elective in lieu of SYST 505 as part of the MS program. The technical elective must be approved by the student's advisor and the SEOR Chair.

In addition to the accelerated MSSE degree, accelerated degrees in BSSE / MSOR and BSSE / MSDAEN (with the predictive analytics or financial engineering concentration) are also available following the previous guidelines. However, for the MSDAEN program, only OR 541 and SYST 573 from the previous table can double count.

6. Transfer Students

- Transfer credit evaluations are considered final after the first semester of enrollment. *This means that students should make sure that all classes have transferred properly before the end of their first semester.*
- Information on course equivalencies between other institutions of higher education and George Mason University can be found at http://admissions.gmu.edu/transfer/TransferCreditSearch.asp.
- Some 300+ level courses transfer as ***lower-division*** courses even though the equivalent Mason course is 300-level or higher. This is designated by a "-L" in the Mason transcript (e.g., "CEIE 310-L"). Such courses do *not* count toward the required 45 credits of upper-division classes.
- All transfer students must take SYST 220, SYST 320, and SYST 330 in order to graduate with a BS degree in Systems Engineering.

The following comments apply specifically to transfer students from VCCS:

- Specific information on VCCS course equivalencies for the BSSE can be found at: http://admissions.gmu.edu/TransferGuide/?program=syst_bs
- A student's admission letter states whether the student is admitted under a Guaranteed Admissions Agreement (GAA). Only students admitted under a GAA are eligible for the Mason Core waiver (this is shown in the degree audit once the final transcript has been processed, but may not appear during orientation). Having an AS degree is not sufficient. For further details, see: http://admissions.gmu.edu/transfer/gaa.asp.
- Students are not permitted to take courses at NVCC to complete AS degrees once they are enrolled at Mason. To qualify for the GAA, the AS must be completed before enrollment at Mason.
- VCCS general education requirements are similar to Mason Core requirements. Thus, students who do not qualify for the Mason Core waiver may not have many general education requirements to complete after entering Mason. Students should work closely with their VCCS advisor to select elective courses that will count toward Mason Core requirements.

7. Change of Major

Students who have completed at least one semester at Mason and who are considering changing their major to any VSE Engineering program should consult with the Volgenau School of Engineering Coordinator of Undergraduate Advising, 2500 Nguyen Engineering Building. These students must have successfully completed MATH 114, PHYS 160 and PHYS 161 (with a grade of at least C) and should have a minimum Mason GPA of 2.75 in all technical coursework. Technical coursework refers to any math, physics, engineering, statistics and computer science courses completed thus far at Mason and that are applicable to the intended engineering major. At least 6 credits of these technical courses should have been completed successfully at Mason. Exceptions to the policy may only be granted at the discretion of the Chair or Associate Chair of the department. If any technical courses have been taken at other institutions then the grades earned at those institutions may be used in the evaluation.

8. Systems Engineering Course Descriptions

The following courses, listed in the catalogue under the SYST or OR designator, may be taken by undergraduate students. Courses numbered 500 or above require approval by the student's advisor and the Chair of SEOR.

101 Understanding Systems Engineering (3:3:0). *Prerequisite: None.* Introduces systems engineering and curriculum for BS in field. Introduces large and small systems, and explains them through some hands-on experiences. Key concepts include understanding requirements for system and translation of system-level requirements to component-level requirements. Several different kinds of example systems presented and discussed: objectives, major components, how system works, and major design issues. Each student gives similar presentation on system of choice. Students working in groups design, develop and test system, and give oral presentation. Students responsible for writing several short papers on curriculum and presentations they have heard. s

198 Independent Study in Systems Engineering (1-3:0:0) Must be arranged with instructor and approved by department chair before registering. Directed self-study of special topics of current interest in systems engineering. May be repeated for maximum 6 credits if topics are substantially different. f,s,sum

202 Engineering Systems in a Complex World (3:3:0). *Prerequisite: None*. This course introduces students to the study of engineering systems as a means of understanding larger historical trends in a global society. Students will use case studies and

historical analyses to think strategically and globally about the management and execution of complex systems in the context of culture, environment, politics and economics, and learn how to employ such analyses as decision-making tools for leadership. Students will be required to critically analyze articles and books, and work in groups to investigate and present topics of current national and international relevance.

210 Systems Design (3:3:0). *Prerequisite: SYST 101 or sophomore standing*. Systems engineering design and integration process, development of functional, physical, and operational architectures. Emphasizes requirements engineering, functional modeling for design, and formulation and analysis of physical design alternatives. Introduces methods, software tools for systems engineering design. f

220 Dynamical Systems I (3:3:0). *Prerequisites: MATH 114 or MATH 116, PHYS 160; corequisites: MATH 203, SYST 221*. Introduces modeling of dynamical systems. Formulation of mathematical models from system descriptions, including computer, biological, economic, transportation, and mechanical systems. Analytical and numerical methods for solving models and studying their behavior. Discrete-time and continuous- time systems. Linear and nonlinear systems. Introduction to computer modeling using MATLAB. s

221 Systems Modeling Laboratory (1:0:3). *Prerequisites: SYST 101, CS 112; corequisite: SYST 220*. Companion laboratory to SYST 220. Emphasizes system design and analysis using computer modeling environment MATLAB. Simulation and numerical solutions of continuous dynamic systems. Use of built-in functions and construction of macros. Graphical presentation of results. s

320 Dynamical Systems II (3:3:0). *Prerequisites: SYST 220, MATH 203, 214, PHYS 260; prerequisites enforced by the registration system.* Continuation of SYST 220 with emphasis in continuous-time systems. Translational, rotational, and electrical systems. Block diagrams and state-variable models. Systems analysis in time domain and frequency domain. Analysis of control systems. f

330 Systems Methods (3:3:0). *Prerequisite: MATH 114 or MATH 116; corequisites: STAT 344, SYST 221*. The objective of this course is to provide students with a general introduction to a variety of quantitative techniques that are relevant to systems engineering. The focus is on the use of quantitative techniques to model and evaluate design options. The scope of this course includes: Analysis methods of systems engineering design and management, decision analysis, models for engineering economics and evaluation, probability and statistical methods for data analysis, management control techniques, safety, reliability, and maintainability analysis, risk and uncertainty management, and life cycle cost analysis. s

335/OR 335 Discrete Systems Modeling and Simulation (3:3:0). *Prerequisites: CS 112 or equivalent, and STAT 344 or STAT 346 or MATH 351; corequisite: CS 211.* An introduction to the basic concepts of modeling complex discrete systems by computer simulation. Topics include Monte-Carlo methods, discrete-event modeling, specialized simulation software, and the statistics of input and output analysis. s

371 Systems Engineering Management (3:3:0). *Corequisites: SYST 210, 330.* Study of the basics of systems engineering management. This includes engineering economics, planning, organizing, staffing, monitoring, and controlling the process of designing, developing, and producing a system that will meet a stated need in an effective and efficient manner. Management tools, processes, and procedures will be discussed, including various engineering documentation templates, managerial processes, and dealing with personnel issues. s

395 Applied Systems Engineering (3:3:0). *Prerequisites: Grade of C or better in SYST 101 and SYST 210; corequisites: SYST 220, 221, 335, 371.* The course will enhance the student's system engineering experience by designing and building projects involving real world complex systems. The course will build physical models that follow the steps of system life cycle process: statement of need, design, requirements, architecture, implementation, testing, verification and validation. Projects are multidisciplinary in nature, requiring the student to learn about various real world systems such as internet communications, navigation, robotics, creating a GUI, and transmitting and receiving data from sensors. s

420 Network Analysis (3:3:0). *Prerequisites: OR 441; MATH 213 or MATH 215; prerequisites enforced by the registration system.* Network nomenclature. Elementary graph theory. Linear and nonlinear network models: multicommodity flow, mathematical games and equilibria on networks, network design and control; dynamic network models; applications to transportation, telecommunications, data communications, and water resource systems. f

421/ECE 421 Classical Systems and Control Theory (3:3:0). *Prerequisite: grade of C or better in ECE 220.* Introduction to the analysis and synthesis of feedback systems. Functional description of linear and nonlinear systems. Block diagrams and signal flow graphs. State-space representation of dynamical systems. Frequency response methods: Root Locus, Nyquist, and other stability criteria. Application to mechanical and electromechanical control systems. f,s,sum

438 Analytics for Financial Engineering and Econometrics (3:3:0). *Prerequisites: Grade of C or better in SYST 330, grade of C or better in STAT 344; corequisite: STAT 354.* Introduces the basic analytics for financial engineering and econometrics; topics include financial transactions and econometric data management, correlation, linear and multiple regressions for financial and economic predictions, stochastic dynamic models and financial time series analysis. Provides a foundation of basic theory and methodology as well as applied examples with techniques to analyzing large financial and econometric data. f

460 Introduction to Air Traffic Control (3:3:0). *Prerequisite: junior standing or graduate standing.* This course is intended as an introduction to Air Traffic Control (ATC) for those who plan professions in the aviation industry. It is a non-quantitative course suitable for non-specialists, as well as a necessary introduction for students who will later specialize and take more in-depth courses. The course will survey the entire field, presenting the history of ATC and how it came to be as it is, the technology on which the

system is based, the procedures used by controllers to meet the safety and efficiency goals of the system, the organizational structure of the FAA, challenges facing the system and means under investigation to meet these challenges. f

461 Air Transportation System Engineering (3:3:0). *Prerequisite: SYST 460 or permission of instructor.* This is a course on the theory and practice of system engineering a national air transportation system. The course will stress the application of mathematical techniques to analyze and design complex network transportation systems, airports, airspace, airline schedules, and traffic flow. The course will require use of MATLAB, VenSim, SAS/R, and FACET. However, prior knowledge of these tools is not needed. S

462 Flight Training Lab I (0:3:0). *Corequisite: SYST 460.* This course fulfills the requirements of 14 CFR, Section 141, Appendix B for obtaining a private pilot certificate with airplane category, single engine land class rating. Flight Training I will include the flight training up to and including maneuvering and navigating the aircraft.

463 Flight Training Lab II (0:3:0). *Prerequisite 462.* This course fulfills the requirements of 14 CFR, Section 141, Appendix B for obtaining a private pilot certificate with airplane category, Airplane – Single Engine Land class rating. Flight Training II will include the flight training up to and including the dual and solo flight instruction in cross-country navigation by pilotage, dead reckoning, and use of VOR, NDB and HIS. Flight test preparation for private pilot certification.

465/ECON 496/MATH 493 Pricing in Optimization and Game Theory (3:3:0). *Prerequisites: MATH 203 or 216, and OR 441, or permission of instructor.* Allocation of limited resources among competing activities to maximize the outcome, or minimization of expenses required to produce a given assortment of goods and services are two typical problems faced by any economic institution. Mathematical modeling of such problems and finding efficient mathematical tools for solving them are two main goals of modern optimization theory. Pricing limited recourses, goods and services is the key instrument for theoretical analysis of complex economical systems. Pricing theory can also give rise to numerical methods for finding optimal solutions and economic equilibrium. Fundamental tools in pricing theory are the classical Lagrangian and Lagrange multipliers for constrained optimization. In this course we will cover the basic ideas and methods of Linear Programming and Matrix Games. Particular emphasize will be given to pricing for both theoretical analysis and numerical methods. s.

468 Applied Predictive Analytics (3:3:0). *Prerequisites: Grade of C or better in STAT 344 or STAT 346 or MATH 351 or STAT 250; Grade of C or better in CS 112 or IT 206. Limited to 2 attempts.* This course introduces students to the fundamentals of data analysis and some of the most widely used models in applied predictive analytics. The students learn how to summarize data and explore relationship between variables, including principle component analysis and multidimensional scaling. Class instruction follows with a presentation of commonly used tables, visualizations, and statistical tests for comparing groups. Linear predictive models for both continuous and binary outcomes (logistic regression) are discussed in detail. The course introduces students to clustering and classification using random forest and naïve Bayes. The course concludes with topics on choice modeling. Hands-on programming with R is emphasized. While no prior knowledge on R is required, students must be well prepared in programming. s.

469 Human Computer Interaction (3:3:0). *Prerequisites: Grade of C or better in STAT 344 or STAT 346 or MATH 351 or STAT 250; IT 106 or CS 112.* This course will cover the principals of human-computer interaction: including information processing design, cognitive models, ergonomics, and design metaphors. Students will learn to evaluate interface design in terms of effectiveness, efficiency, and cost. *Students who receive credit for SYST 470 may not receive credit for this course.* f,s.

470 Human Factors Engineering (3:3:0). *Prerequisites: SYST 210, STAT 344; prerequisites enforced by the registration system.* Human information processing, inferential analysis, biases and heuristics in human information processing, support systems to aid in human information processing, human-system interaction, and software systems engineering considerations. f

473 Decision and Risk Analysis (3:3:0). *Prerequisite: STAT 344 or STAT 346 or MATH 351 or grade of C or better in STAT 250.* This course covers analytic techniques for rational decision making that address uncertainty, conflicting objectives, and risk attitudes. The course covers modeling uncertainty; rational decision-making principles; representing decision problems with value trees, decision trees, and influence diagrams; solving value hierarchies, decision trees and influence diagrams; defining and calculating the value of information; incorporating risk attitudes into the analysis; and conducting sensitivity analyses. f

488 Financial Systems Engineering (3:3:0). *Prerequisite: OR 441.* This course is an introduction to financial engineering. Financial engineering is a cross-disciplinary field which relies on mathematical finance, numerical methods, and computer simulations to make trading, hedging, and investment decisions. This course will introduce basic types of derivatives, such as forward, futures, swaps, and options; as well as financial models such as Brownian motion, Ito's formula, and Black-Scholes model. s

489 Senior Seminar (3:3:0) *Corequisite: SYST 490*. This course introduces students to several important topics in systems engineering, providing additional experience in writing and giving presentations, and obtain feedback on the curriculum for the B.S. in Systems Engineering. Several lectures will be devoted to ethics in systems engineering. Writing and making presentations for systems engineering will also be covered early in the semester. The instructor and guest lecturers will present material that is not part of the required course load to expand the horizons of the students. Each student will write a short paper on each of these presentations. Examples of such "hot" topics are "knowledge-based" design, enterprise-wide reengineering, electronic commerce, and optimization by "natural analogy" (simulated annealing, neural networks, genetic algorithms). In addition, students will work in teams to critique and redesign the curriculum in Systems Engineering. Each group will deliver a written product and provide at least one briefing to the class. The best critique and redesign will be presented to the faculty. f

490 Senior Design Project I (3:2:1). *Prerequisites: Grade of C or better in SYST 335, grade of C or better in SYST 371, grade of C or better in SYST 395, and 90 satisfactory credits towards the BS in systems engineering; corequisites: SYST 320, 470, 473, and OR 441; course restricted only to BSSE majors.* The first part of a "capstone" course in the systems engineering program. Students apply the knowledge they have gained in systems engineering methods to a group project. During the first semester of the senior design

course, students perform concept definition and requirements analysis. A plan for carrying out the project is developed, culminating in a proposal presented to faculty at the end of the semester.

491 Industrial Project (1-3:0:3-9). *Prerequisites: 75 credit hours toward BS in systems engineering, SYST 330, GPA of at least 3.00; must be arranged with an instructor and approved by the department chair before registering.* Semester-long work experience in systems engineering in an industrial or governmental organization. The work is supervised jointly by a systems engineer from the sponsoring organization *and* a faculty member of the department. The project and the arrangements for supervision must be approved by the student's faculty advisor. Periodic reports, a written final report, and a presentation are required. f,s,sum

495 Senior Design Project II (3:1:2). *Prerequisite: Grade of C or better in SYST 320, SYST 470, SYST 473, SYST 490; corequisite SYST 330, STAT 354*. The second part of the "capstone" course in the systems engineering program. The design project plans formulated in SYST 490 are reviewed and modified. Additional instruction on documentation and project management is given. The design project is completed, and a formal report is prepared, presented, and evaluated. s

498 Independent Study in Systems Engineering (1-3:0:0). *Prerequisites: 60 credits; GPA of at least 3.00; Must be arranged with an instructor and approved by the department chair before registering.* Directed self-study of special topics of current interest in systems engineering. May be repeated for a maximum of six credits if the topics are substantially different. f,s,sum

499 Special Topics in Systems Engineering (3:3:0). *Prerequisites: 60 credits; specific prerequisites vary with nature of topic.* Topics of special interest to undergraduates. May be repeated for a maximum of six credits if the topics are substantially different.

521/OR543 Network Analysis (3:3:0). *Prerequisites: MATH 213 or equivalent; OR 441 or 441/541.* Network nomenclature. Elementary graph theory. Linear and nonlinear network models: multicommodity flow, mathematical games and equilibria on networks, network design and control. Dynamic network models. Applications to transportation, telecommunications, data communications, and water resource systems. f,

573 Decision and Risk Analysis (3:3:0). *Prerequisite: STAT 344 or equivalent.* Study of analytic techniques for rational decision making that address uncertainty, conflicting objectives, and risk attitudes. This course covers modeling uncertainty; rational decision-making principles; representing decision problems with value trees, decision trees, and influence diagrams; solving value hierarchies, decision trees, and influence diagrams; defining and calculating the value of information; incorporating risk attitudes into the analysis; and conducting sensitivity analysis. (Offered concurrently with SYST 473. Students may not receive credit for both SYST 473 and SYST 573.) f,s

Operations Research Courses

OR 441/MATH 441 Deterministic Operations Research (3:3:0). *Prerequisite: MATH 203 or permission of instructor.* Survey of deterministic methods for solving "real-world" decision problems. Covers linear programming model and simplex method of solution, duality, and sensitivity analysis; transportation and assignment problems; shortest path and maximal flow problems; and introduction to integer and nonlinear programming. f,s

OR 442/MATH 442 Stochastic Operations Research (3:3:0). *Prerequisites: STAT 344 or STAT 346 or MATH 351 or equivalent.* Survey of probabilistic methods for solving decision problems under uncertainty, probability review, decision theory, queuing theory, inventory models, reliability, Markov chain models, and simulation are covered. Emphasis on modeling and problem solving. f,s

OR 481/MATH 446 Numerical Methods in Engineering (3:3:0). *Prerequisites: Grade of C or better in MATH 203 and CS 112.* Modern numerical methods and software. Emphasis is on problem solving through software and assessing the quality of solutions obtained. Topics include computer arithmetic, linear equations and least squares data fitting, interpolation, nonlinear optimization, and differential equations. The course involves extensive computer use. f,s

OR 541 Operations Research: Deterministic Models (3:3:0). *Prerequisite: MATH 203 or equivalent.* Survey of deterministic methods of solving real world decision problems. Covers linear programming model and simplex method of solution, duality, and sensitivity analysis, transportation and assignment problems; shortest path, minimal spanning tree, and maximal flow problems; and an introduction to integer and nonlinear programming. Emphasis on modeling and problem solving. f,s

OR 542 Operations Research: Stochastic Models (3:3:0). *Prerequisites: STAT 344 or MATH 351 or equivalent.* A survey of probabilistic methods for solving decision problems under uncertainty, probability theory review, reliability, queuing theory, inventory systems, Markov chain models, and simulation. Emphasis on modeling and problem solving. f,s

9. Specialization Course Descriptions

Aviation Systems

SYST 420 Network Analysis. See Section 8.
SYST 460 Introduction to Air Traffic Control. See Section 8.
SYST 461 Air Transportation System Engineering. See Section 8.

Bioengineering

BENG 313 Physiology for Engineers (3:3:0). *Prerequisites: Grade of C or better in BIOL 213 and MATH 113.* This course provides a broad introduction to the subject of human physiology, focusing on learning the subject matter from an engineering viewpoint. Organs and physiological systems where engineering has a significant role are emphasized. f

BENG 304 Modeling and Control of Physiological Systems (3:3:0). *Prerequisites: Grade of C or better in BENG 320, MATH 214 and PHYS 260; Grade of C or better in BIOL 425 or BIOL 430 or BENG 313.* This course will introduce students to a systems-level understanding of biomedical systems. Mathematical modeling of dynamic systems will be emphasized, including the role of feedback. Analogies between electrical and mechanical systems will be discussed. Examples covered will include multiple scales ranging from cells to organ systems. s

BENG 406 Biomechanics (3:3:0). *Prerequisites: Grade of C or better in PHYS 160 (or PHYS 243), MATH 203, MATH 214, BENG 220, and BENG 313.* This course introduces the fundamental principles of musculoskeletal biomechanics, computational simulation of movement, and OpenSim simulator. Topics include functions and models of the musculoskeletal structures, mathematical description of motion, kinetics, and simulation of movement using OpenSim. s

BENG 420 Bioinformatics for Engineers (3:3:0). *Prerequisite: BENG 320.* This course introduces the fundamental techniques and tools for analyzing biomedical data, important for many biomedical engineering problems. Topics include regression, classification, clustering, dimensionality reduction, data representation, pattern matching and algorithm performance evaluation. This innovative course will leverage hybrid learning through a combination of lectures, on-line content, and individual and group projects involving hands-on analysis. f

Note: CHEM 211-3 can be used as a substitute for BIOL 213 as a pre-requisite to take BENG 313. SYST 220/320 can be used as a substitute whenever BENG 220/320 is needed as a pre-requisite.

Computer Network Systems

TCOM 500 Modern Telecommunications (3:2:2). Course is not intended for those majoring in electrical or computer engineering. Introduction to digital systems, circuits, and computers. Topics include binary systems and codes, digital logic gates and circuits, microelectronics and integrated circuits, coding and multiplexing, multivibrators, shift registers, counters, A/D converters, and elementary computer architecture. f,s

SYST 420 Network Analysis. See Section 8.

ECE 465 Computer Networking Protocols (3:3:0). *Prerequisites: STAT 344 or 346, CS 211, and either ECE 331, 301 or TCOM 500.* An introduction to computer networking protocols and concepts, with emphasis on the Internet and the Internet Protocol Suite. Course coverage includes computer networking protocols at the application, transport, and network layers, including multimedia networking protocols. Other topics include network security and network management.

Control Systems

ECE 201 Introduction to Electrical Engineering (3:3:1). *Prerequisite: A grade of C or better in MATH 113.* Provides a technically more rigorous introduction to problems and tools commonly encountered by electrical engineers. Students are introduced to mathematical modeling of engineering problems and their solutions. Standard software packages for electrical engineering are introduced as tools to simulate engineering problems on a computer. Mathematical and computer models are related to physical reality provided by hands-on experiments. f,s

ECE 220 Signals and Systems I (3:3:1). *Prerequisite: C or better in ECE 201 or equivalent; corequisites: MATH 203, 214.* First of a two-semester sequence of courses that provide the mathematical background for many ECE courses taken in the junior and senior years. This course introduces students to methods of representing continuous-time signals and systems and the interaction between signals and systems. Analysis of signals and systems via differential equations and transform methods is discussed. Laplace and Fourier transforms as convenient analysis tools are presented, and the powerful concept of frequency response of systems is emphasized. Stability of systems is studied in both the time and frequency domains. Application examples from communications, circuits, control, and signal processing are presented. f,s,sum

SYST 421 - Classical Systems & Control Theory. See Section 8.

Data Analytics

SYST 438 – Analytics for Financial Engineering and Econometrics. See Section 8.

SYST 468 – Applied Predictive Analytics. See Section 8.

IT 214 Database Fundamentals (3:3:0). *Prerequisite: IT 103 or CS 112.* Covers fundamentals of relational database management systems and their use in business environments. Topics include: database classifications, data models with extensive coverage of the relational model, entity-relationship and extended entity-relationship models, normalization, advanced data modeling, and Structured Query Language (SQL) programming. Students design and implement a real-world relational database and create complex SQL queries to retrieve data from the database. f,s

STAT 463 Introduction to Exploratory Data Analysis (3:3:0). *Prerequisite: STAT 350 or 354, or equivalent.* Features statistical graphics, maps and simple models used to bring out patterns in data. Introduces statistical software and addresses data access and import. Presents exploratory strategies motivating data transformations. Stresses the cognitive foundations of good graphics. Graphics include dot plots, box plots, Q-Q plots, parallel coordinate plots, scatterplot matrices and linked views. Exploration includes use of dynamic graphics. s (alternate years)

Financial Engineering

SYST 438 Analytics for Financial Engineering and Econometrics. See Section 8.
SYST 468 Applied Predictive Analytics. See Section 8.
SYST 488 Financial Systems Engineering. See Section 8.
STAT 463 Introduction to Exploratory Data Analysis. See Data Analytics track

STAT 455 Experimental Design (3:3:0). *Prerequisite: STAT 350 or 354.* Principles of analysis of variance and experimental design. Topics include computation and interpretation of analysis of variance; multiple comparisons; orthogonal contrasts; and design of experiments, including factorial, hierarchical, and split plot designs. Optional topics may include analysis of covariance; partial hierarchical designs; incomplete block designs; principles of blocking and confounding in 2**n experiments; or estimation of variance components. Computer statistical packages are used to perform computations. s (alternate years)

Mechanical Engineering

ME 211 Statics (3:3:0). *Prerequisites: Grade of C or better in PHYS 160, 161.* An initial course in applied vector mechanics with emphasis on static equilibrium. Topics include forces, moments, couples, equivalent force-couple systems, centroids, distributed forces, and Coulomb friction. The application of the free body diagram in the analysis of static equilibrium of frames, machines and trusses is stressed. f,s

ME 212 Solid Mechanics (3:3:0). *Prerequisite: Grade of C or better in ME 211.* A first course in mechanics of deformable bodies with emphasis on the engineering approach to the responses of these bodies to various types of loadings. Topics include stress-strain relationships, stress-strain analysis, stress and strain transformation (Mohr's circle), load-deflection, bending, torsion, buckling, and thermal effects. f,s

ME 221 Thermodynamics (3:3:0). *Corequisite: MATH 214.* A basic thermodynamics course in which the first and second laws of thermodynamics are studied primarily from the classical macroscopic viewpoint and applied to both closed and open systems. Working substances include perfect gases, real gases and vapors in addition to solids and liquids. f,s

ME 231 Dynamics (3:3:0). *Prerequisite: ME 221; corequisite: MATH 214.* A course in classical vector dynamics. Topics include vector algebra and calculus, kinematics and kinetics of particles and rigid bodies, as well as energy and momentum methods. Extensive problem solving involving particle and rigid body motion is required. f,s

ME 322 Fluid Mechanics (3:3:0). *Prerequisite: Grade of C or better in ME 221.* An introductory course in fluid dynamics stressing both the integral and differential forms of the conservation laws of fluid flow. Engineering applications are made to hydrostatics and to ideal and real fluid flows. f,s

ME 323 Heat Transfer (3:3:0). *Prerequisite: Grade of C or better in ME 322.* Study of thermal radiation, steady and transient conduction, laminar and turbulent convection, internal and external flow, boundary layers and empirical correlations. Applications address fins, nuclear reactor cooling, heat exchangers and interactive computing. f,s

ME 341 Design of Mechanical Elements (3:3:0). *Prerequisite: Grade of C or better in ME 212.* Fundamentals of mechanical design. Introduction to the fundamentals of static and fatigue failure theories, design of basic machine elements such as fasteners, bearings, gearing and shafts. Builds on the fundamentals of design introduced in earlier courses by introducing the concepts of customer requirements, specification development, reverse engineering, functional decomposition, and design for manufacturing. f,s
ME 342 Design of Thermal Systems (3:3:0). *Prerequisite: Grade of C or better in ME 221.* A study of equipment which operates on principles of thermodynamics and fluid mechanics is used to reinforce analyses and design of gas and vapor power cycles, refrigeration and air conditioning, propulsion systems, combustion, energy conversion and compressible flow. f,s

CEIE 210 Statics and Dynamics (3:3:0). *Prerequisites: PHYS 160 and MATH 114.* General principles and fundamental concepts. Units of measurement. Force vectors and their use, including vector operations. Equilibrium of a particle. Resultants of a system of forces. Equilibrium of a rigid body. Dry friction. Center of gravity and centroid. Moments of inertia, including the parallel axis theorem and radius of gyration. Kinematics of a particle. Work and energy. f,s

CEIE 310 Mechanics of Materials (3:3:0). *Prerequisite: CEIE 210.* Concepts of stress, strain, elasticity, and plasticity. Stress and strain analysis, including the use of Mohr's circle. Pure torsion. Theory of pure bending and members under transverse loading, including normal and shear stress analysis. Theory of elastic buckling. Distribution of internal forces in statically determinate systems, including beams, frames, and arches. f

Operations Research

SYST 420 Network Analysis. See Section 8.

SYST 468 Applied Predictive Analytics. See Section 8.

OR 481 Numerical Methods in Engineering. See Section 8.

Software-Intensive Systems

CS 310 Data Structures (3:3:0). *Prerequisite: Grade of C or better in CS 211 and MATH 113; corequisite: CS 105.* Focuses on object-oriented programming with an emphasis on tools and techniques for developing moderate to large programs. Topics include use and implementation of linear and nonlinear data structures, and the design and analysis of elementary algorithms. f,s

Note: BSSE majors should complete an override form from the CS department indicating that they do not have to take CS 105 in order to take CS 310.

CS 321 Software Engineering (3:3:0). *Prerequisites: Grade of C or better in CS 310 and ENGH 302.* An introduction to concepts, methods, and tools for the creation of large-scale software systems. Methods, tools, notations, and validation techniques to analyze, specify, prototype, and maintain software requirements. Introduction to object-oriented requirements modeling, including use of case modeling, static modeling, and dynamic modeling using the Unified Modeling Language (UML) notation. Concepts and methods for the design of large-scale software systems. Fundamental design concepts and design notations are introduced. A study of object-oriented analysis and design modeling using the UML notation. Students participate in a group project on software requirements, specification, and object-oriented software design.

CS 332 Object-Oriented Software Design and Implementation (3:3:0). *Prerequisite: Grade of C or better in CS 211.* In-depth study of software design and implementation using a modern, object-oriented language with support for graphical user interfaces and complex data structures. Topics covered will be specifications, design patterns, and abstraction techniques, including typing, access control, inheritance, and polymorphism. Students will learn the proper engineering use of techniques such as information hiding, classes, objects, inheritance, exception handling, event-based systems, and concurrency.

10. Required Courses from Other Departments

CHEM 251 General Chemistry for Engineers, or
CHEM 211-3 General Chemistry and Laboratory, or
PHYS 262-3 University Physics III and Laboratory, or
BIOL 213 Cell Structure and Function
COMM 100 Public Speaking, or
COMM 101 Interpersonal and Group Interaction
CS 112 Introduction to Computer Programming
CS 211 Object-Oriented Programming
ENGH 101 Composition
ENGH 302 Advanced Composition (natural sciences)
Literature Elective
ECON 103 Contemporary Microeconomic Principles
ENGR 107 Introduction to Engineering
HIST 100 History of Western Civilization or HIST 125 Introduction to World History
Global Understanding approved elective
Fine Arts approved elective
PHYS 160-1 University Physics I and Laboratory
PHYS 260-1 University Physics II and Laboratory
MATH 113 Analytic Geometry and Calculus I
MATH 114 Analytic Geometry and Calculus II
MATH 213 Analytic Geometry and Calculus III
MATH 203 Linear Algebra
MATH 214 Elementary Differential Equations
STAT 344 Probability and Statistics for Engineers and Scientists I
STAT 354 Probability and Statistics for Engineering and Scientists II

11. Systems Engineering and Operations Research Faculty

Adelman, Leonard, Ph.D., University of Colorado, Professor

Brouse, S. Peggy, Ph.D., George Mason University, Associate Professor

Chang, Kuo-Chu, Ph.D., University of Connecticut, Professor

Chen, Chun-Hung, Ph.D., Harvard University, Professor

Clemons, Thomas, Ph.D., George Mason University, Associate Professor

Costa, Paulo, Ph.D., George Mason University, Associate Professor

Donohue, George, Ph.D., Oklahoma State University, Professor Emeritus

El-Amine, Hadi, Ph.D., Virginia Tech, Assistant Professor

Ganesan, Rajesh, Ph.D., University of South Florida, Associate Professor

Hoffman, Karla L., Sc.D., The George Washington University; Professor

Huang, Chien Huang., Ph.D., Georgia Institute of Technology, Assistant Professor

Ji, Ran, Ph.D., The George Washington University, Assistant Professor

Jones, Rochelle, Ph.D., University of Central Florida, Associate Professor

Laskey, Kathryn B., Ph.D., Carnegie Mellon University, Professor

Loerch, Andrew, Ph.D., Cornell University, Associate Professor

Nash, Stephen G., Ph.D., Stanford University, Professor

Pyster, Art, Ph.D., The Ohio State University, Professor

Sherry, Lance A., Ph.D., Arizona State University, Associate Professor

Shortle, John, Ph.D., University of California, Berkeley, Professor and Chair

Sofer, Ariela, Sc.D., The George Washington University, Professor

Sokolov, Vadim, Ph.D., Northern Illinois University, Assistant Professor

Xu, Jie, Ph.D., Northwestern University, Associate Professor

Zaidi, Syed Abbas. Ph.D., George Mason University, Professor

Adjunct Professors: Alexander, Bailey, Burke, Charbonneau, Comer, Ferreiro, Killam, Laveson, Morris, Mulhearn, Nicholas, Rothwell, Wieland.

12. Sample Schedules

This section contains sample schedules for undergraduate systems engineering majors. The sample schedules given here cover a wide variety of cases (four-year students, transfer students, accelerated BS/MS students).

Students should follow the sample schedules as closely as possible.

The sample schedules have been constructed to satisfy all prerequisite requirements. Be careful when creating a schedule that deviates from the relevant sample schedule. Deviations from the sample schedule may result in missing prerequisites for later classes, thus requiring postponement of the later classes. Further, most SEOR courses are offered only once per year and not during the summer. Also note that prerequisites and corequisites apply recursively. For example, if MATH 114 if a prerequisite for a course, then MATH 113 is also, by default, a prerequisite for the same course even if not explicitly listed as a prerequisite, since MATH 113 is a prerequisite for MATH 114.

The position of the technical elective courses within the schedule will vary depending on the specialization, and the position of some Mason Core classes may vary as well. Consult with your advisor to plan the correct sequence.

Sample Schedule for 4-Year Undergraduate Students

This sample schedule applies to students who begin their program at Mason and who place into MATH 113.

First Semester		Second Semester	
COMM 100 – Public Speaking (or COMM 101)	3	CS 112 – Introduction to Computer Programming	4
ECON 103 – Contemporary Microeconomic Principles	3	MATH 114 – Analytic Geometry & Calculus II	4
ENGH 101 – Composition[2]	3	PHYS 160 – University Physics I	3
ENGR 107 – Introduction to Engineering	2	PHYS 161 – University Physics I Lab	1
MATH 113 – Analytic Geometry & Calculus I	4	SYST 101 – Understanding Systems Engineering	3
	15		15

Third Semester		Fourth Semester	
CS 211 – Object-Oriented Programming	3	CHEM 211-3 or CHEM 251 or PHYS 262-3 or BIOL 213	4
MATH 213 – Analytic Geometry & Calculus III	3	MATH 203 – Linear Algebra	3
PHYS 260 – University Physics II	3	MATH 214 – Elementary Differential Equations	3
PHYS 261 – University Physics II Lab	1	SYST 220 – Dynamical Systems I	3
SYST 210 – Systems Design	3	SYST 221 – Systems Modeling Lab	1
Literature Elective	3	Arts Elective	3
	16		17

Fifth Semester		Sixth Semester	
SYST 320 – Dynamical Systems II	3	SYST 330 – Systems Methods	3
OR 441 – Deterministic Operations Research	3	SYST 335 – Discrete Systems Modeling and Simulation	3
STAT 344– Probability and Statistics for Engineers I	3	SYST 371 – Systems Engineering Management	3
ENGH 302 – Advanced Composition for Natural Sciences	3	STAT 354 – Probability and Statistics for Engineering II	3
Technical Elective	3	SYST 395 – Applied Systems Engineering	3
	15		15

Seventh Semester		Eighth Semester	
SYST 470 – Human Factors Engineering	3	SYST 495 – Senior Design Project II	3
SYST 489 - Senior Seminar	3	OR 442 – Stochastic Operations Research	3
SYST 490 – Senior Design Project I	3	Technical Elective	3
SYST 473 – Decision and Risk Analysis	3	Global Understanding approved elective	3
Technical Elective	3	HIST 100 – History of Western Civilization or HIST 125 – Introduction to World History	3
	15		15

[2] Or ENGH 100 for non-native English speakers

Sample Schedule for Students Who Do Not Place Into MATH 113

This alternate schedule (for the first two years) applies to students who begin their program at Mason, but who do not place into MATH 113.

First Semester		Second Semester	
COMM 100 – Public Speaking (or COMM 101)	3	CS 112 – Introduction to Computer Programming	4
ECON 103 – Contemporary Microeconomic Principles	3	CHEM 211-3 or CHEM 251 or PHYS 262-3 or BIOL 213	4
ENGH 101 – Composition[3]	3	MATH 113 – Analytic Geometry & Calculus I	4
ENGR 107 – Introduction to Engineering	2	SYST 101 – Understanding Systems Engineering	3
MATH 105 – Precalculus Mathematics	3		
	14		15
Summer			
MATH 114 – Analytic Geometry & Calculus II	4		

Third Semester		Fourth Semester	
CS 211 – Object-Oriented Programming	3	MATH 203 – Linear Algebra	3
MATH 213 – Analytic Geometry & Calculus III	3	MATH 214 – Elementary Differential Equations	3
PHYS 160 – University Physics I	3	PHYS 260 – University Physics II	3
PHYS 161 – University Physics I Lab	1	PHYS 261 – University Physics II Lab	1
SYST 210 – Systems Design	3	SYST 220 – Dynamical Systems I	3
Literature Elective	3	SYST 221 – Systems Modeling Lab	1
		Arts Elective	3
	16		17

[3] Or ENGH 100 for non-native English speakers

SAMPLE SCHEDULE FOR B.S. IN SYSTEMS ENGINEERING FOR TRANSFER STUDENTS

This sample schedule applies to students who transfer into Mason. *The actual schedule is likely to vary depending on the transfer credits received and the specialization chosen*. The schedule assumes that students have received transfer credit for all mathematics, physics, and natural science classes required for the BSSE, with the possible exception of MATH 214. The schedule also assumes students have taken ENGR 107, CS 112, and many of the Mason core requirements. Some specializations may require students to take 18 credits during one or more semesters.

Students who have completed the Associate of Science in Engineering degree at VCCS will have credit for ME 211, 212 and 231. These are the technical electives in the Mechanical Engineering specialization for the BSSE degree. Other students may need to take technical electives at Mason.

NOTE: Transfer credit evaluations are considered final after the first semester of enrollment. *This means that students should make sure that all classes have transferred properly before the end of their first semester.*

Fifth Semester		Sixth Semester	
SYST 101– Understanding Systems Engineering	3	SYST 220 – Dynamical Systems I	3
SYST 210 – Systems Design	3	SYST 221 – Systems Modeling Lab	1
OR 441 – Deterministic Operations Research	3	SYST 330 – Systems Methods	3
STAT 344– Probability and Statistics for Engineers & Scientists I	3	SYST 335 – Discrete Systems Modeling and Simulation	3
CS 211 – Object-Oriented Programming	3	SYST 371 – Systems Engineering Management	3
MATH 214 – Elementary Differential Equations (if needed)	3	SYST 395 – Applied Systems Engineering	3
	18		16
Seventh Semester		Eighth Semester	
SYST 320 – Dynamic Systems II	3	SYST 495 – Senior Design Project II	3
SYST 470 – Human Factors Engineering	3	OR 442 – Stochastic Operations Research	3
SYST 489 - Senior Seminar	3	Technical Elective (if needed)	3
SYST 490 – Senior Design Project I	3	Technical Elective or Mason Core (if needed)	3
SYST 473 – Decision and Risk Analysis	3	STAT 354 – Probability and Statistics for Engineers & Scientists II	3
Technical Elective (if needed)	3	ENGH 302 – Advanced Composition for Natural Sciences	3
	18		18

The following is an alternative schedule for student who have not taken Linear Algebra prior to arriving at Mason

Fifth Semester		Sixth Semester	
SYST 101 –Understanding Systems Engineering	3	SYST 220 – Dynamical Systems I	3
SYST 210 – Systems Design	3	SYST 221 – Systems Modeling Lab	1
MATH 203- Linear Algebra	3	SYST 330 – Systems Methods	3
STAT 344– Probability and Statistics for Engineers & Scientists I	3	SYST 335 – Discrete Systems Modeling and Simulation	3
CS 211 – Object-Oriented Programming	3	SYST 371 – Systems Engineering Management	3
Technical Elective (if needed) or MATH 214 – Elementary Differential Equations (if needed)	3	SYST 395 – Applied Systems Engineering	3
	18		16
Summer (if needed)			
MATH 214 – Elementary Differential Equations	3		
	3		
Seventh Semester		Eighth Semester	
SYST 320 – Dynamic Systems II	3	SYST 495 – Senior Design Project II	3
SYST 470 – Human Factors Engineering	3	OR 442 – Stochastic Operations Research	3
SYST 489 - Senior Seminar	3	Technical Elective (if needed)	3
SYST 490 – Senior Design Project I	3	Technical Elective or Mason Core (if needed)	3
SYST 473 – Decision and Risk Analysis	3	STAT 354 – Probability and Statistics for Engineers & Scientists II	3
OR 441 – Deterministic Operations Research	3	ENGH 302 – Advanced Composition for Natural Sciences	3
	18		18

Note: Students who take CS 112 in 5th semester, must take CS 211 in 6th semester, SYST 330 in 8th semester, and ENGH 302 over summer.

Sample Schedule for 4-Year Accelerated BS/MS Students

This sample schedule applies to students who begin their program at Mason and who are accepted in the accelerated BS/MS program. Courses in **bold** denote changes from the standard 4-year sample schedule. This sample schedule assumes that students take SYST 573 and OR 542 as their graduate courses. The actual schedule may vary if other courses are selected for the accelerated BS/MS.

Seventh Semester		Eighth Semester	
SYST 470 – Human Factors Engineering	3	SYST 495 – Senior Design Project II	3
SYST 489 - Senior Seminar	3	**OR 542 Stochastic Operations Research**	**3**
SYST 490 – Senior Design Project I	3	Technical Elective	3
SYST 573 – Decision and Risk Analysis	3	Global Understanding approved elective	3
Technical Elective	3	HIST 100 – History of Western Civilization or HIST 125 – Introduction to World History	3
	15		15

Scheduling of Specialization Courses

The following table may be helpful in scheduling the technical electives within the plan of study. The last set of columns indicate possible sequencing of the three courses. Other sequences may also be possible. Course offerings are subject to change, so students should double-check feasibility with respect to prerequisites and scheduling.

				Possible Semester Sequence*				
				6/7/8	7/8/8	7/7/8	5/7/8	5/8/8
Aviation	Suggested Slot	Key Prerequisites	Offered	No	No	Yes	Yes	No
SYST 460	Fall, Jr.	Junior standing	Fall					
SYST 461	Spring, Jr.	SYST 460	Spr.					
SYST 420	Fall, Sr.	OR 441	Fall					
Bioengineering	Suggested Slot	Key Prerequisites	Offered	No	Yes	Yes	Yes	Yes
BENG 313	Fall, Sr.	BIOL 213, MATH 113	Fall					
BENG 304	Spring, Sr.	PHYS 260, MATH 214, SYST 320, BENG 313	Spr.					
BENG 406	Spring, Sr.	PHYS 160, MATH 203, 214, SYST 220, BENG 313	Spr.					
BENG 420	Fall, Sr.	SYST 320	Fall					
Comp. Network	Suggested Slot	Key Prerequisites	Offered	Yes	Yes	Yes	Yes	Yes
SYST 420	Fall, Sr.	OR 441	Fall					
ECE 465	Spring, Sr.	STAT 344, CS 211	Spr.					
TCOM 500	Spring, Sr.	Grad. Standing	Fall / Spr.					
Control	Suggested Slot	Key Prerequisites	Offered	Yes	No	No	Yes	No
ECE 201	Spring, Jr.	MATH 113	Fall / Spr.					
ECE 220	Fall, Sr.	ECE 201	Fall / Spr.					
SYST 421	Spring, Sr.	ECE 220	Fall / Spr.					
Data Analytics	Suggested Slot	Key Prerequisites	Offered	Yes	Yes	Yes	Yes	No
IT 214	Fall Jr.	CS 112	Fall / Spr.					
SYST 438	Fall Sr.	SYST 330, STAT 354 (co-req)	Fall					
STAT 463	Spring, Sr.	STAT 354	Spr. 2018, 20, …					
SYST 468	Spring, Sr.	STAT 344, CS 112	Spr.					
Fincancial	Suggested Slot	Key Prerequisites	Offered	Yes	Yes	No	No	Yes
SYST 438	Fall, Sr.	SYST 330, STAT 354 (co-req)	Fall					
STAT 455	Spring, Sr.	STAT 354	Spr. 2017, 19, …					
STAT 463	Spring, Sr.	STAT 354	Spr. 2018, 20, …					
SYST 468	Spring Sr.	STAT 344, CS 112	Spr.					
SYST 488	Spring, Sr.	OR 441	Spr.					
Mech. Design	Suggested Slot	Key Prerequisites	Offered	Yes	No	No	Yes	No
ME 211	Spring, Jr.	PHYS 160, 161	Fall / Spr.					
ME 212	Fall, Sr.	ME 211	Fall / Spr.					
ME 341	Spring, Sr.	ME 212	Fall / Spr.					
CEIE 210	Spring, Jr.	PHYS 160, MATH 114	Fall / Spr.					
CEIE 310	Fall, Sr.	CEIE 210	Fall / Spr.					
ME 231	Spring, Sr.	ME 211, MATH 214 (co-req)	Fall / Spr.					
Mech. Fluids	Suggested Slot	Key Prerequisites	Offered	Yes	Yes	No	Yes	Yes
ME 221	Spring, Jr.	MATH 214 (co-req)	Fall / Spr.					
ME 322	Fall, Sr.	ME 221	Fall / Spr.					
ME 323	Spring, Sr.	ME 322	Fall / Spr.					
ME 342	Spring, Sr.	ME 221	Fall / Spr.					
OR	Suggested Slot	Key Prerequisites	Offered	Yes	Yes	Yes	Yes	No
OR 481	Spring, Jr.	MATH 203, 213	Fall / Spr.					
SYST 420	Fall, Sr.	OR 441	Fall					
SYST 468	Spring, Sr.	STAT 344, CS 112	Spr.					
Software	Suggested Slot	Key Prerequisites	Offered	Yes	Yes	No	Yes	Yes
CS 310	Spring, Jr.	CS 211, MATH 113	Fall / Spr.					
CS 332	Fall, Sr.	CS 211	Fall					
CS 321	Spring, Sr.	CS 310, ENGH 302	Fall / Spr.					
* 5 = Fall, Jr., 6 = Spring, Jr., 7 = Fall, Sr., 8 = Spring, Sr.								

Note: CEIE 210 and CEIE 310 both have 2 hours of lecture and 3 hours of lab (5 hours total) each week.

PROGRESS REPORT AND PLAN OF STUDY FOR B.S. IN SYSTEMS ENGINEERING

Student _____ __ **G#** _____ **Email** _____ **Ph.No.** _____

1st Sem/Year at GMU _____ **Advisor's Name** _____ Date _____

Sem/Year this form was filled out _____

Instructions:

1) **PRINT OUT YOUR DEGREE ANALYSIS FROM PATRIOTWEB. TO REVIEW YOUR PROGRESS, ENTER LATEST GRADES OF ALL COURSES YOU HAVE ALREADY TAKEN. MARK TRANSFER COURSES SHOWING IN YOUR DEGREE ANALYSIS WITH A "T". PUT CHECK MARKS (✓) ON COURSES YOU ARE CURRENTLY TAKING. FILL OUT THE PLAN OF STUDY FORM (NEXT PAGE) TO SHOW COURSES YOU WILL BE TAKING FOR THE COMING SEMESTERS.**
2) NOTE: No math, science, or VSE course, required for the major, may be attempted more than three times. Those students who do not successfully complete such a course within three attempts will be terminated from the major.

*For catalog year **prior** to Fall 2014, CS 211, PHYS 260, MATH 203, MATH 214 and STAT 354 do not require a grade of C or better.
For catalog year **prior to Fall 2015, SYST 395 is not required. ***CHEM 211 corequisite not required for BIOL 213

Grade	First Semester (Fall_____)	
	COMM 100 or COMM 101 (Fa / Sp)	3
	ECON 103 (Fa / Sp)	3
	ENGH 101 (Fa / Sp) C or better	3
	ENGR 107 (Fa / Sp)	2
	MATH 113 (Fa / Sp) C or better	4
		15

Grade	Second Semester (Spring _____)	
	CS 112 (Fa / Sp) C or better	4
	MATH 114 (Fa / Sp) C or better	4
	PHYS 160 (Fa / Sp) C or better	3
	PHYS 161 (Fa / Sp) C or better	1
	SYST 101 (Fa / Sp) C or better	3
		15

	Third Semester (Fall_____)	
	CS 211 (Fa / Sp) C or better*	3
	MATH 213 (Fa / Sp) C or better	3
	PHYS 260 (Fa / Sp) C or better*	3
	PHYS 261 (Fa / Sp)	1
	SYST 210 (Fa / Sp) C or better	3
	Literature Elective _____	3
		16

	Fourth Semester (Spring _____)	
	CHEM 211-3 or 251 or BIOL 213 or PHYS 262-3	4
	MATH 203 (Fa / Sp) C or better*	3
	MATH 214 (Fa / Sp) C or better*	3
	SYST 220 (**Spring only**) C or better	3
	SYST 221 (**Spring only**) C or better	1
	Arts Elective _____	3
		17

	Fifth Semester (Fall_____)	
	SYST 320 (**Fall only**) C or better	3
	OR 441 (Fa / Sp) C or better	3
	STAT 344 (Fa / Sp) C or better	3
	ENGH 302 (Fa / Sp) C or better	3
	Technical Elective _____	3
	(C or better)	15

	Sixth Semester (Spring _____)	
	SYST 330 (**Spring only**) C or better	3
	SYST 335 (**Spring only**) C or better	3
	STAT 354 (Fa / Sp) C or better*	3
	SYST 371 (**Spring only**) C or better	3
	SYST 395 (**Spring only**) C or better	3
		15

	Seventh Semester (Fall_____)	
	SYST 470 (**Fall only**) C or better	3
	SYST 473 (**Fall only**) C or better	3
	SYST 489 (**Fall only**) C or better	3
	SYST 490 (**Fall only**) C or better	3
	Technical Elective _____	3
	(C or better)	15

	Eighth Semester (Spring _____)	
	SYST 495 (**Spring only**) C or better	3
	OR 442 (Fa / Sp) C or better	3
	Global Understanding _____	3
	HIST 100 or HIST 125	3
	Technical Elective _____	3
	(C or better)	15

Technical Emphasis _____ (See attached for list of courses)

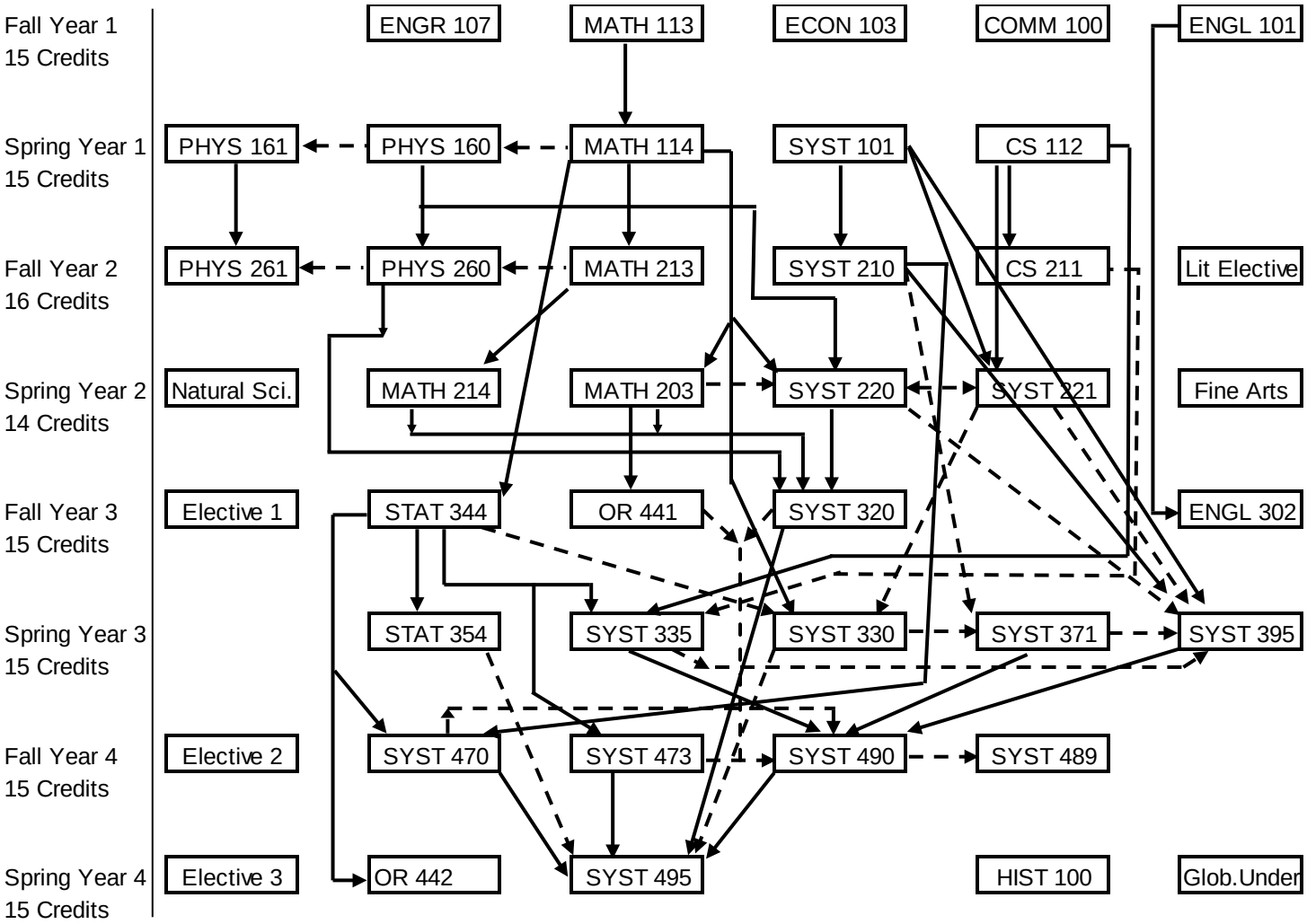
Student's Signature	**Date**	**Advisor's Signature**	**Date**	**Chair's Signature**	**Date**
_____	_____	_____	_____	_____	_____

Semester-hour credits must total at least 123 hours, at least 45 of which must be at the 300 or above level courses. Note Transfer courses labeled with an "L" in the GMU equivalent course do not count towards the 45 hours of 300 or above level courses. At least one-fourth of the total semester hours must be taken at GMU in order to satisfy the residency requirements.

Students must attach a degree evaluation with this plan of study. The above signatures indicate that the degree evaluation is attached and has been reviewed in particular to identify transfer credits that do or do not apply to this program.

Prerequisites for the BSSE

The following chart shows the prerequisite sequences for required courses in the SE program. Prerequisites for technical elective sequences vary with the specialization area and the specific electives chosen. ***It is essential for students to complete their mathematics and physics courses as early as possible because many later courses have these courses as prerequisites.***



Prerequisite Diagram for Required Courses in BSSE Program

(Solid lines represent prerequisites; dashed lines represent corequisites)

Students taking SYST 490 must have 90 satisfactory credits applicable to the BS degree.

Name _____ Plan of Study

Fall _____	Credits	**Spring** _____	Credits	**Summer** _____	Credits
Fall _____		**Spring** _____		**Summer** _____	
Fall _____		**Spring** _____		**Summer** _____	
Fall _____		**Spring** _____		**Summer** _____	

Technical Emphasis Areas (Grade of C or better)

Aviation System: SYST 420 (**Fall only**), SYST 460 (**Fall only**), SYST 461 (**Spring only**)

Bioengineering: BENG 313 (Fall and Spring) and two from BENG 304 (Fall and Spring), BENG 406 (**Spring only**), BENG 420 (Fall and Spring)

Computer Network Systems: SYST 420 (**Fall only**), ECE 465 (Fall and Spring), TCOM 500 (Fall and Spring)

Control Systems: ECE 201, ECE 220, SYST 421 (all Fall and Spring)

Data Analytics: SYST 468 (**Spring only**), IT 214 (Fall and Spring), SYST 438 (**Fall only**) **or** STAT 463 (**Alternate Spring only**)

Financial Engineering: SYST 438 (**Fall only**), SYST 488 (**Spring only**), SYST 468 (**Spring only**) **or** STAT 463 **or** STAT 455 (**Alternate Spring only**)

Mechanical Engineering (Design): ME 211 **or** CEIE 210, ME 212 **or** CEIE 310, ME 341 **or** ME 231 (all Fall and Spring)

Mechanical Engineering (Thermal Fluid): ME 221, ME 322, ME 323 **or** ME 342 (all Fall and Spring)

Operations Research: OR 481 (Fall and Spring), SYST 420 (**Fall only**), SYST 468 (**Spring only**)

Software-Intensive Systems: CS 310 (Fall and Spring), CS 321 (Fall and Spring), CS 332 (**Fall only**)

BS SYSTEMS ENGINEERING: LIST OF ALL COURSE REQUIREMENTS (TOTAL CREDITS 123)

Mathematics and Statistics Credits 23

____MATH 113 - Analytic Geometry and Calculus I
____MATH 114 - Analytic Geometry and Calculus II **Prereq(s)** C or better in MATH 113
____MATH 203 - Linear Algebra **Prereq(s)** C or better in MATH 114 or MATH 116
____MATH 213 - Analytic Geometry and Calculus III **Prereq(s)** C or better in MATH 114 or MATH 116
____MATH 214 - Elementary Differential Equations **Prereq(s)** Grade of C or better in MATH 213 or 215
____STAT 344 - Probability and Statistics for Engineers and Scientists I **Prereq(s)** MATH 114 or MATH 116
____STAT 354 - Probability and Statistics for Engineers and Scientists II **Prereq(s)** STAT 344

Natural Sciences Credits 12

____PHYS 160 - University Physics I **Coreq(s)** MATH 114
____PHYS 161 - University Physics I Laboratory **Coreq(s)** PHYS 160 and MATH 114
____PHYS 260 - University Physics II **Prereq(s)** PHYS 160 with a grade of C or better **Coreq(s)** MATH 213
____PHYS 261 - University Physics II Laboratory **Prereq(s)** PHYS 161 **Coreq(s)** MATH 213 and PHYS 260
____PHYS 262 - University Physics III **Prereq(s)** PHYS 260 with a grade of C or better **Coreq(s)** MATH 214 **and**
____PHYS 263 - University Physics III Laboratory **Prereq(s)** PHYS 261 **Coreq(s)** PHYS 262 **or**
____CHEM 251 - General Chemistry for Engineers **or**
____CHEM 211 - General Chemistry and CHEM 213 General Chemistry Laboratory **or**
____BIOL 213 - Cell Structure and Function **Coreq(s)** CHEM 211 (coreq waived for BSSE students)

Computer Science Credits 7

____CS 112 - Introduction to Computer Programming **Prereq(s)** C or better in MATH 104 or MATH 105 or MATH 113
____CS 211 - Object-Oriented Programming **Prereq(s)** Grade of C or better in CS 112

Communication and Economics Credits 6

____COMM 100 - Public Speaking **or**
____COMM 101 - Interpersonal and Group Interaction
____ECON 103 - Contemporary Microeconomic Principles

Engineering Credits 2

____ENGR 107 - Introduction to Engineering

Systems Engineering Credits 55

____SYST 101 - Understanding Systems Engineering
____SYST 210 - Systems Design **Prereq(s)** SYST 101 or sophomore standing
____SYST 220 - Dynamical Systems I **Prereq(s)** MATH 114 or MATH 116 and PHYS 160 **Coreq(s)** MATH 203 and SYST 221
____SYST 221 - Systems Modeling Laboratory **Prereq(s)** SYST 101, CS 112 **Coreq(s)** SYST 220
____SYST 320 - Dynamical Systems II **Prereq(s)** SYST 220, MATH 203, MATH 214, PHYS 260
____SYST 330 - Systems Methods **Prereq(s)** MATH 114 or MATH 116 **Coreq(s)** STAT 344 and SYST 221
____SYST 335 - Discrete Systems Modeling and Simulation **Prereq(s)** CS 112 and STAT 344 or MATH 351 **Coreq(s)** CS 211
____SYST 371 - Systems Engineering Management **Coreq(s)** SYST 210 and SYST 330
____SYST 395 - Applied Systems Engineering **Prereq(s)** Grade of C or better in SYST 101 and SYST 210 **Coreq(s)** SYST 220, SYST 221, SYST 335, SYST 371
____SYST 470 - Human Factors Engineering **Prereq(s)** SYST 210 and STAT 344
____SYST 473 - Decision and Risk Analysis **Prereq(s)** STAT 344 or STAT 346 or MATH 351 or grade of C or better in STAT 250
____SYST 489 - Senior Seminar **Coreq(s)** SYST 490
____SYST 490 - Senior Design Project I **Prereq(s)** SYST 335, SYST 371, SYST 395, and 90 credits **Coreq(s)** SYST 320, SYST 470, SYST 473, and OR 441
____SYST 495 - Senior Design Project II **Prereq(s)** Grade of C or better in SYST 490 **Coreq(s)** SYST 330, STAT 354
____OR 441 - Deterministic Operations Research **Prereq(s)** MATH 203, or permission of instructor
____OR 442 - Stochastic Operations Research **Prereq(s)** STAT 344 or STAT 346 or MATH 351
____3 approved technical electives selected from one of the Technical Emphasis Areas. Credits 9

Additional Mason Core Credits 18

Students must complete all Mason Core requirements not fulfilled by major requirements.
____ENGH 101 - Composition
____ENGH 302 - Advanced Composition (must complete a natural sciences and technology section)
____Literature
____Arts
____Western Civilization/World History
____Global Understanding