This report was edited and produced by the Department of Operational Sciences, Graduate School of Engineering and Management, Air Force Institute of Technology. The Department of Defense, other federal government, and non-government agencies supported the work reported herein, but have not reviewed or endorsed the contents of this report.

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Or visit the Department of Operational Sciences website: http://www.afit.edu/ENS/

The Department of Operational Sciences Executive Manager, 937-255-3636 (ext 3136) is responsible for the contents of this document.
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PREFACE

The Department of Operational Sciences, Graduate School of Engineering and Management, Air Force Institute of Technology provides graduate educational programs through the doctoral level and academic research in the areas of operations research and logistics and supply chain management. Our faculty and staff are dedicated to the following:

- offering degree programs that prepare the next generation of defense and industry analysts and leaders,
- creating cutting edge knowledge that contributes to solving the major problems facing modern society focusing on the defense of that society,
- responding to the needs of all of our customers and research partners, and
- providing an environment of rigor and mentorship that fosters academic excellence.

This brochure provides an introduction to the Department and serves as a guide for students and faculty advisors in the preparation of educational plans for the academic programs offered: Master of Science in Logistics and Supply Chain Management, Master of Science in Operations Research, Master of Science in Logistics (Distance Learning), Master of Science in Operations Management (ASAM), Doctor of Philosophy in Logistics, Doctorate of Philosophy in Operations Research, Certificate in Supply Chain Management, Certificate in Test and Evaluation, Certificate in Data Science and the Certificate in Cost Capability Analysis. The requirements and curricula specified in this 2019-2020 edition of the brochure apply to all students admitted into and commencing academic programs during academic year 2019-2020 (October 2019 through September 2020.) Course descriptions and projected course offering schedules are also provided in this brochure. Additional information on courses, programs, and admissions procedures may be found in the AFIT catalog, AFIT web site, and applicable other brochures.

This brochure represents the offerings, programs, and requirements in effect at the time of publication, but there is no guarantee that they will not be changed or revoked, as a result of continual examination for improvement, or due to unforeseen circumstances. The Department reserves the right to change any provision, offering, or requirement to be effective when determined by the Department, or if applicable, when approved by the Dean of the Graduate School. However, adequate and reasonable notice will be given to students affected by any change. This brochure is not intended to state contractual terms and should not be regarded as a contract between the student and the Department.

Further questions regarding academic programs should be referred to the Department of Operational Sciences, AFIT/ENS, as indicated below:

Mail: AFIT/ENS, 2950 Hobson Way, Wright-Patterson AFB, Ohio 45433-7765

Phone: Commercial (937)255-2549; or DSN 785-2549

Office: Area B, Wright Patterson Air Force Base, Bldg 641, Suite 201
CHAPTER 1: INTRODUCTION

The Department of Operational Sciences is a dynamic team of faculty and staff, located in an outstanding facility, who are dedicated to the precept of our Mission Statement:

*Through defense-focused graduate education in Logistics and Supply Chain Management and Operations Research, provide our Air Force and its U.S. and allied partners with exceptionally qualified critical and forward thinking analysts and managers while contributing high quality on-target research and technology transfer to our customers.*

We are always seeking top-quality graduate students interested in obtaining a degree or graduate level certificate in the exciting fields of operations research & logistics and supply chain management. Military personnel as well as U.S. citizen civilians are students in our department. All our programs share a common element: a project or research-based experience. We are proud of our alumni, who are strongly encouraged to keep in touch with us and visit the department. We are also continually engaged with and seeking additional defense and industrial partners who want to have access to the latest developments in the fields of logistics and supply chain management and operations research. We have a varied and active portfolio of project and research engagements which involve the faculty, students, laboratories, and our Center for Operational Analysis (COA) and our Scientific Test and Analysis Techniques (STAT) in Test and Evaluation Center of Excellence (COE).

**Programs Offered**
- Doctor of Philosophy (Operations Research)
- Doctor of Philosophy (Logistics)
- Master of Science in Operations Research
- Master of Science in Logistics and Supply Chain Management
- Master of Science in Logistics (Distance Learning)
- Master of Science in Operations Management (ASAM)
- Graduate Certificate in Cost Capability Analysis
- Graduate Certificate in Test and Evaluation
- Graduate Certificate in Supply Chain Management
- Graduate Certificate in Data Science

**Department Affiliated Center and Laboratory Resources**
- Center for Operational Analysis (COA)
- Scientific Test and Analysis Techniques (STAT) for Test and Evaluation (T&E) Center of Excellence (CoE)
- Advanced Laboratory for Test and Optimization
- Combat Modeling Laboratory
- Future Operations Investigation Laboratory
- Joint Deployment & Distribution Environment (JDDE) Laboratory
- Manpower Personnel Modeling
- Science of Test Research Lab
- Sensor Laboratory
Historical Background

The Logistics Side

In 1954, General Edwin W. Rawlings, Commander of Air Material Command (AMC), concluded that he needed some form of graduate-level education dedicated to logistics for the AMC people who were making logistics decisions and forming logistics policy. In February 1955, the Institute of Technology [the designation “Air Force Institute of Technology (AFIT)” was adopted for the first time on 16 April 1956] was authorized to establish an experimental Advanced Logistics course that would include research in logistics problem areas and instruction in logistics concepts. The non-accredited course, known as the Logistics Education and Research Project (LERP), was launched with 24 students on 10 October 1955, with the first class graduating on 24 April 1956. By 1959 AFIT—or IT as it was redesignated on 1 July 1959 by Air University—had five major elements, including the School of Logistics. In May 1961, the Institute announced plans to expand from the nine months it had grown to by then to twelve months to allow the addition of quantitative courses, reflecting the increased importance of research data simulation to the Air Force.

On 1 January 1962 the Institute became “the Air Force Institute of Technology” once more, and in February 1963, Air University redesignated the logistics school as the School of Systems and Logistics. On 1 April 1960, AFIT was designated as a master’s degree-granting institution by the North Central Association (NCA) regional accreditation agency; and on 16 March 1963, the NCA granted accreditation to the graduate logistics program of the School of Systems and Logistics (then located in Bldg 288, Area A). Subsequently, on 3 June 1963, AFIT granted its first Master of Science in Logistics Management to students whose curriculum had been accredited. That same month, the first official Graduate Logistics class began with 19 students: 15 Air Force, two Army officers, one Navy officer, and one Department of Defense Civilian. By 1965-66, the United States had 184,000 troops in Vietnam, with another 200,000 going in 1966; enormously impacting the concept of logistics, with the waging of counter-guerrilla warfare creating logistical problems not lending themselves to conventional solutions. Responding to the requirements presented by the wartime situation, the School of Systems and Logistics reorganized for efficiency into a directorate for graduate education, another for continuing education, and a third for curriculum development.

The 1970s saw a period of AFIT organizational and facility consolidation, including the relocation of the School of Systems and Logistics from Area A, to the newly constructed building 641 dedicated on 4 October 1977, alongside School of Engineering (EN). The 1990’s saw another major period of AFIT consolidation directly impacting its then 20+ year old logistics program: the organizational realignment along the lines of graduate and Professional Continuing Education (PCE) to recognize the unique nature of each. In 1992, all graduate level logistics programs were placed under the newly created School of Logistics and Acquisition Management (AFIT/LA), while the logistics PCE programs remained under the School of Systems and Logistics (AFIT/LS). On 24 August 1993, the LA was officially designated as the Graduate School of Logistics and Acquisition Management, organized into three teaching departments, one of which, the Department of Graduate Logistics Management (LAL), became the precursor of the Logistics Division now residing within the Department of Operational Sciences.
By the mid 1990s, LAL offered a Master of Science in Logistics Management with five options allowing for concentration in a single field: Graduate Logistics Management (GLM), Graduate Maintenance Management (GMM), Graduate Supply (Inventory) Management (GIM), Graduate Transportation Management (GTM), and Graduate Acquisition Logistics Management (GAL). In September 1994, the Commander, Air Mobility Command asked AFIT to establish a degree-granting program in Air Mobility to address large-scale mobility operations. In response, AFIT developed a 14-month program taught on-site at the Air Mobility Warfare Center, Ft. Dix, New Jersey, by offering a Master’s of Air Mobility (GMO) that supported the Air Mobility Warfare Center’s Advanced Studies in Air Mobility (ASAM) program, starting in March 1995. The AFIT GMO program was approved by the North Central Association, and the first class of 10 graduated with a master’s degree in May 1996. AFIT established a new degree program, the Master of Operations Management (OPSMGT), with the potential of multiple specialty tracks (ASAM) for different MAJCOMS. The OPSMGMT program provides AFIT greater flexibility in responding to future command requested programs.

The Operations Research Side
Meanwhile, until the mid-1970s AFIT had never explicitly developed programs to provide education to the operational Air Force. On June 6, 1974, the first masters level operations research class (GOR-75D) commenced their studies and on December 19, 1975 that first class graduated, with 18 students awarded their M.S. (Operations Research) degrees. In 1976, while attending the Air War College, the Dean of the School of Engineering identified a lack of application of hard analytical tools to problems in strategy and tactics. To remedy this, he proposed to Air Staff that the School of Engineering establish a graduate program in Strategic and Tactical Sciences to prepare officers with operational backgrounds for strategic and tactical operations, evaluation, analysis, and planning roles in the 1980s and beyond. The Chief of Staff approved the program in March 1977, with the first class arriving in August of that year, made up of fifteen senior captains and junior majors with degrees in science or engineering, and experience as pilots, navigators or missile crewmen, whose AFIT graduate curriculum combined study of quantitative sciences, weapons engineering, and military operations.

The Department of Operational Sciences (AFIT/ENS) continued the rigorous quantitative and evaluative approach to operational issues envisioned at its genesis, and by 1990s, the Department offered three programs leading to the Master of Science degree in three specializations: operations research (GOR); strategic and tactical sciences (GOA—later redesignated as operational analysis); and space operations (GSO, which later moved to the Department of Aeronautics and Astronautics.) The Department of Operational Sciences also inaugurated a Ph.D. program, with the first student arriving in September 1989 and graduating in 1992.

In 1993, the ENS Department Head stood up the Center for Modeling and Simulation and Analysis (CMSA) as a compliment to the academic department, with the original computer lab space located in building 640. The CMSA was established with the purpose of providing an environment with quality resources designed to encourage and enhance faculty and student interactions leading to the production of exceptional research that addressed current problems faced by research sponsors.
Logistics and Operations Research Merge – 1999 and beyond

Academic Programs

The most recent AFIT reorganization affecting graduate logistics and operational sciences programs commenced in 1996 when, to meet changing Air Force educational requirements, AFIT began a major restructuring initiative. The lengthy restructuring process was finalized effective 1 October 1999, when the Graduate School of Engineering (AFIT/EN) and the Graduate School of Logistics and Acquisition Management (AFIT/LA) consolidated into one Graduate School of Engineering and Management (AFIT/EN). That merger resulted in the programs previously offered by Department of Graduate Logistics Management (LAL) being relocated within the Department of Operational Sciences (AFIT/ENS)—the departmental configuration that continues to the present.

During 2002, the Air Force made significant changes to the officer professional military education program, resulting in the inclusion of graduate education programs as an option into which an Air Force officer in the rank of major or senior captain selected by a special board for Intermediate Service School (ISS) might be placed in FY03. AFIT, including ENS, supported this new initiative by accepting ISS selectees into appropriate pre-existing 18-month thesis programs that first year. By late FY03, ISS had become known as Intermediate Developmental Education (IDE); and by FY04, ENS, as well as other academic departments, had implemented specifically-designed non-thesis 12-month operations and logistics master’s programs with curricula addressing both the technical and leadership/management needs uniquely tailored to the IDE- selected future leaders of the Air Force. Additionally, Air Force leadership recognized the ASAM program along with ENS’s pre-existing non-thesis Master in Air Mobility program component as well suited to be included as an IDE graduate program selectee option. IDE selectees continue to attend ENS’s Master of Science in Logistics and Master of Science in Operations Analysis programs. And, students selected for ASAM IDE continue to pursue their air mobility logistics master’s curriculum, taught by ENS faculty traveling to Ft. Dix each quarter. Since June 2009, these ASAM students also now receive a Master of Science in Logistics degree.

Moving forward and responding to the continually evolving operational and logistical and supply chain demands of an actively engaged Air Force world-wide, ENS continues to update program offerings to meet Air Force needs. Taking advantage of education delivery system innovations, the Department established two graduate-level certificate programs targeted at students with DoD organizational funding, both available by distance learning: the Graduate Certificate in Supply Chain Management (9 August 2007) and the Test and Evaluation Certificate Program (20 November 2008). Similarly reflecting Air Force mission requirements, two new specializations have been added to 18-month the Master of Science in Logistics and Supply Chain Management programs: Petroleum Management (11 Feb 2009) and Nuclear Logistics Management (Fall Quarter 2010).

On April 14, 2010, the Dean of the AFIT Graduate School of Engineering and Management approved the proposal for the Ph.D. program with specialization in Logistics submitted by the Department of Operational Sciences, and authorized the program to be offered commencing in the fall of 2010. This new doctoral program is significant both because it is only the second new
doctoral program added to the Graduate School’s catalog in the last twenty years, and because it is also the first doctoral program in the logistics/management discipline to be offered by AFIT. Subsequently, the Department of Operational Sciences graduated the first Logistics doctoral student in 2013.

**Logistics and Operations Merge – 1999 and beyond**

**Centers and Facilities**

Within the Department, evolution saw the CMSA’s name change to the Center for Operational and Defense Analysis, which in 2003 was renamed the Center for Operational Analysis (COA). Noteworthy also in March 2003, the COA was formally recognized as an AFIT Center of Excellence. COA growth and activity continued, with academic year 2008-09 beginning a period of significant growth in research and sponsor funding associated with the Center. Fiscal year 2009 reflected that growth, with the COA-associated Department of Operational Sciences faculty members receiving $2.5 million in research funding that year alone, up from an average of approximately $500,000 for each of the previous four fiscal years. In 2012, COA research funding increased to $6.5 million. As of fiscal year 2013, COA research funding stabilized at $4.8 million.

The Center for Operational Analysis (COA) is the premier research facility within the Air Force Institute of Technology (AFIT) Graduate School of Engineering and Management, which directly supports Department of Defense (DoD) strategic objectives. Throughout the DoD, there is a common theme regarding problem solving for the future: a continuous effort to achieve “greater agility, innovation, and integration” (*National Military Strategy, 2015*). In the *Air Force Future Operating Concept* (September 2015), operational agility is defined as “the ability to rapidly generate—and shift among—multiple solutions for a given challenge.” Efforts to increase AFIT’s operational agility include new capability developments ranging from advancing and modernizing education to operational employment through innovative approaches to state-of-the-art training that utilizes modeling and simulation. This constant evolution requires institutional changes in the COA’s approaches to problem solving, and consistent advancement in the pursuit of rapidly changing technology that continues to revolutionize everything we do. In short, these measures are a call to the future.

Recognizing this “call to the future,” the COA must become more agile in leveraging technology and alternative learning opportunities. Through synergy between the Graduate School of Engineering and Management, Department of Operational Sciences’ staff, and with the new, increased reach-back potential to our industry partners, the COA will increase its agility and support the Chancellor in achieving his vision of AFIT becoming “… an internationally-recognized and respected leader for defense-focused technical graduate and continuing education, and related research and consultation.” To facilitate this transition, the COA is being strategically rebuilt, repurposed, and refocused to fill the information, knowledge, and research gaps between the DoD, Air Force, academia, and our industry partners. The COA currently generates $4.6M in Sponsored Research.

On April 13, 2012, Deputy Assistant Secretary of Defense, Edward R. Greer, in coordination with the Commander, Air Education and Training Command and the Director of Air Force Test and Evaluation signed the memorandum announcing the establishment of the Scientific Test and Analysis Techniques (STAT) for Test and Evaluation (T&E) Center of Excellence at the Air
The Force Institute of Technology, within the Department of Operational Sciences. The establishment of this new Center—now commonly known as the “COE”—here at AFIT acknowledges AFIT as a leader in the field of Test and Evaluation. The COE assists acquisition programs in developing rigorous, defensible test strategies to more effectively quantify and characterize system performance and provide information that reduces risk. Goals of the COE are to work directly for CAT I acquisition Program Managers supporting their efforts for more rigorous T&E, capture STAT best practices for wider dissemination, develop case studies that exemplify appropriate use of STAT in achieving more rigorous T&E, and provide training at the point of need to ensure program-led rigor in testing. Each year, the DASD(DT&E) includes the support offered by the COE in its report to Congress. Additionally, since 2012 DOT&E has highlighted the COE’s work in its report to Congress. The COE has grown from support of 20 to 36 CAT I acquisition programs. The COE received $2.7 million in research funding in its initial year, FY12, attaining full operational capability in July 2012 and celebrated with an official ribbon cutting ceremony on October 18, 2012. The COE continued to receive $1.5 million in research funding for each additional year since its inception with growth to over $3 million in research funding for FY16.

During the Department’s and its predecessors’ history, its physical facilities had resided in a succession of locations, some mentioned above. In October 2008, Department faculty and staff, along with the Center for Operational Analysis, including COA computer lab, made its final move into newly remodeled space, now occupying the majority of the second floor of building 641 (Twining Hall) in the AFIT complex, Area B, Wright-Patterson AFB, Ohio.

The remainder of this brochure describes the programs and faculty of this dynamic, energized, and proactively engaged academic department.

Historical information compiled primarily from:


*History of the Air Force Institute of Technology: 1 Jan – 31 Dec 1996*

*History of Air University, 1 January 1997 – 31 December 1998, Volume 1—Narrative*

*History of Air University, 1 January 1999 – 31 December 1999, Volume 1—Narrative*

2.1 ADMISSION

Individuals wishing to attend AFIT graduate-level classes, whether full-time or part time, must first be admitted to the Graduate School of Engineering and Management. General requirements for admission are discussed in the AFIT Catalog and on the Graduate School [http://www.afit.edu/ADMISSIONS/](http://www.afit.edu/ADMISSIONS/) which also provides an on-line application form. With the exception of officers and civilians in selected foreign military services who are sponsored by their government, admission to the Graduate School of Engineering is restricted to citizens of the United States.

Admission to the Graduate School of Engineering and Management is administered by the Admissions Office (AFIT/ENER), which executes admission policy approved by the Dean and academic departments. Air Force personnel seeking an assignment to AFIT to obtain a graduate degree will be evaluated for eligibility only—the prospective officer student must also request assignment to AFIT through their assignment team at Headquarters, Air Force Personnel Center and be selected by that agency in order to receive an AFIT graduate school assignment; prospective enlisted students must apply in accordance with the directives announced by Headquarters, Air Force Personnel Center. Selection and assignment information specific to active duty Air Force members is available at the AFIT Admission Office web site at [http://www.afit.edu/ADMISSIONS/page.cfm?page=467&tabname=Tab3A](http://www.afit.edu/ADMISSIONS/page.cfm?page=467&tabname=Tab3A). Sister Service members and U.S. Department of Defense civilian employees seeking full government sponsorship, must also be evaluated for academic eligibility, and if academically qualified, apply for assignment to AFIT in accordance to their agency directives. Academically qualified local Department of Defense military and civilian employees, as well as DoD contractors, may also be admitted and will be responsible providing or securing tuition payment. Applicants who are not DoD employees should contact the Admissions Office and the Department of Operational Sciences for detailed information regarding admission requirements. Academically qualified foreign national officers and civilians sponsored by their governments are processed for assignment to AFIT programs through AFIT’s International Affairs Office. All other qualified students will be admitted either unconditionally or conditionally, depending upon their academic qualifications relative to the requested program requirements and/or completeness of their academic documents presented to the Admissions Office.

Admission to the Graduate School of Engineering and Management does not guarantee admission to a specific degree program within the Department of Operational Sciences. However, when application is made through the Admissions Office for a program offered by the Department of Operational Sciences, and the applicant meets academic and documentation requirements, admission is granted to that specific academic program. The Department of Operational Sciences faculty reserves the right to waive specific admission requirements for individual applicants on a case-by-case basis.
For more information about admission procedures and requirements, contact: AFIT Admission Office, 2950 Hobson Way, Wright-Patterson AFB, Ohio 45433-7765.
Ph: 1-800-211-5097 ext 3184; com (937)255-6234 ext 3184; or DSN 785-6234 ext 3184.
Email: http://www.afit.edu/ADMISSIONS/facdir.cfm

2.2 COURSE REGISTRATION AND CREDIT
Students are responsible for registering for classes. A normal course load for degree-seeking students attending AFIT full-time is 12 to 16 quarter hours. Non-degree-seeking students will typically register for no more than eight-quarter hours.

Registration for all students is accomplished during the open registration period, which normally begins by Monday of the third week of the quarter preceding the course offering, and extending to Friday of the first week of the quarter in which the course is offered. Students will receive various notifications advising them of registration dates. Registration is accomplished on line by logging onto WebAdvisor at (link available on the AFIT Intranet available to AFIT faculty, staff, and students) and entering their courses through the registration screen. Students who do not have access to WebAdvisor must complete the AFIT Drop/Add Request Form. This form is available in the ENS office, on-line, and the Registrar’s Office. Students are responsible for resolving all resultant scheduling conflicts and ensuring that they have the approval of their academic advisor.

For assistance and guidance regarding course registration, add/drop deadlines, academic calendars, term course schedules, and other course enrollment issues, visit the Registrar’s Office at http://www.afit.edu/ENER/, contact the Registrar’s Office or ask the ENS Training Administrator for assistance.
CHAPTER 3: GENERAL MS DEGREE REQUIREMENTS

All of the Master of Science degrees offered by the Department of Operational Sciences adhere to the general requirements for the Master of Science degree established by the AFIT Graduate School of Engineering and Management. A summary of these requirements follows. For more complete information see the current Graduate School of Engineering and Management Catalog, http://www.afit.edu/ENER/doclib.cfm?dl=31, and for the final authority on these requirements, the reader should consult Graduate School of Engineering and Management Operating Instructions (ENOI) 36-135, 27 Feb 2012, “Requirements for Award of the Master’s Degree.” The general MS requirements are:

(1) Attain the bachelor’s degree with major in an appropriate field, or the equivalent, at least three quarters prior to the date of graduation.

(2) Applied for admission as a candidate for the degree at least one year prior to graduation. This application must be endorsed by the major department and approved by the Dean (full time DoD-sponsored students and some full-time scholarship recipients are designated candidates upon matriculation).

(3) Completed at least 48-quarter hours of required graduate courses and approved graduate electives, 36 of which must be in-residence. In residence courses are courses appearing on the AFIT transcript as AFIT offerings, including courses offered by consortium institutions such as the Dayton Area Graduate Studies Institute (DAGSI). The number of credit hours offered by the Graduate School of Engineering and Management (excluding thesis hours) must be at least 50% of the total non-thesis credit hours submitted for the degree.

(4) Complete the independent investigation requirement (IDE programs excluded).

(5) Attain a grade point average of at least 3.00 for all graded courses included in the “all courses taken” block of the student’s Education Plan and Program Summary (AFIT Form 69.)

(6) Achieve grades of at least "C-" or “S” in all courses required for the degree. Grades of “D”, “F”, or “U” are considered academic deficiencies and must be resolved under the provision of E NOI 36-104.

(7) Complete all degree requirements within six calendar years after applying for admission as a candidate for the degree (five years from graduation of the student’s class section for full-time DoD sponsored students) except as specified in E NOI 36-113.

(8) The student must be recommended for the degree by the Faculty Council of the Graduate School of Engineering and Management before the degree will be awarded.
CHAPTER 4: MASTER DEGREE PROGRAM GUIDES

4.1 MASTER OF SCIENCE IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

4.1.1 THE DEGREE

The Commander, Air University, is authorized by Public Law 733 of the 83d Congress to confer degrees upon persons who meet all requirements for those degrees as established by AFIT. The Institute is accredited by the North Central Association of Colleges and Schools through the doctoral level. The Graduate Logistics and Supply Chain Management (LSCMGT) program leads to the degree of Master of Science in Logistics and Supply Chain Management.

4.1.2 THE PROGRAM

For DoD-sponsored full-time students, the LSCMGT program requires 18 months (6 academic quarters) of full-time study and begins in August of each year. Other students must complete a minimum of 48 credit hours of coursework and thesis research, as specified in the AFIT LSCMGT Form 69. The program is directed by the Department of Operational Sciences of the Graduate School of Engineering and Management (AFIT/ENS), 2950 Hobson Way, Bldg 641, Wright-Patterson AFB, OH 45433-7765 (DSN 785-2549, Commercial 937-255-2549).

The LSCMGT program provides students with the opportunity to learn and exercise state-of-the-art management knowledge and tools to solve defense acquisition and logistics problems. Upon completion, students are granted a Master of Science degree. The curriculum includes courses in statistics, operations research, organization and management theory, inventory systems, transportation and strategic mobility, maintenance and production management, financial management, and economics. In addition, students have the opportunity of either pursuing an Operational Logistics, Operational Maintenance, Petroleum Management, Life Cycle Logistics, or Nuclear Logistics Management track. All graduates of the LSCMGT program should be able to:

1. Communicate effectively (oral and written)
2. Understand and apply the concepts, methods, and tools related to planning, directing, and controlling resources (people, material, equipment, and funds) in a logistics context
3. Analyze the impacts of changes in the defense transportation network on other functional areas within the total defense logistics system
4. Understand and apply acquisition logistics and integrated logistics support concepts to affect weapon system life cycles
5. Comprehend the role of the general logistician in the DoD and Air Force for planning, acquiring, distributing, supplying, and maintaining weapon systems
6. Conduct and present methodical research to solve problems and support decisions

4.1.3 PROGRAM GRADUATES

Active duty and military-affiliated graduates are well grounded in course work related to follow-on assignments within the logistics career field (21XX for Air Force officers) as well as other duties in support of weapon systems acquisition and sustainment at the base, major command (MAJCOM), and higher levels. For Air Force military/civilian employees, the output academic degree codes are 1AMJ (acquisition logistics), 1AMY (logistics management), 1AMS (supply management), 1ATY (transportation management), 1CBF (petroleum management), 1AMM (maintenance management), and 1AMN (nuclear logistics management). Generally, the 1AMS, 1AMY, and 1ATY students are in the Operational Logistics (OL) track, the 1AMM students are in the Operational Maintenance (OM) track, the 1CBF students are in the Petroleum Management (PM) track, the 1AMJ students are in the Life Cycle Logistics (LC) track, and the 1AMN students are in the Nuclear Logistics (NL) Management track. Civilian graduates are well prepared for any career or position requiring a high level of expertise in logistics and supply chain theory and problem application.

4.1.4 ADMISSION CRITERIA AND PROCEDURES

The general requirements for admission to the LSCMGT program in the Department of Operational Sciences are:

1. A baccalaureate degree or equivalent
2. A cumulative undergraduate GPA of 3.00 (on a 4.00 scale)
3. Graduate Records Examination (GRE) score with a minimum of 153 (verbal) and 148 (quantitative), or Graduate Management Admissions Test (GMAT) score of at least 550
4. Mathematics through college algebra with a grade of C or higher

Students in the Wright Patterson area who do not meet these criteria may register for individual courses as a part-time student in order to demonstrate their ability to do satisfactory graduate work. Waivers to the above requirements may be granted on an individual basis by the Department of Operational Sciences. Admission procedures are specified in the Graduate School home page at http://www.afit.edu/en/admissions/index.cfm.

Potential applicants may submit a request for evaluation of eligibility at any time. To apply for an in-resident AFIT graduate degree program, please visit http://www.afit.edu/en/Admissions, and look for "Application Forms" on the left menu bar. Select the form that best describes you. Fill out the application form and submit it per the instructions on the form. If you have problems transmitting the application form, fax it to Commercial (937) 255-2791 or DSN 785-2791 or you may mail the application to AFIT/ENER, BLDG 641 Room 102, 2950 HOBSOM WAY, WRIGHT-PATTERSON AFB, OH 45433-7765. To speak with an admissions counselor, call AFIT Admissions at Commercial 1-800-211-5097 or (937) 255-6234 or DSN 785-6234. If your
last name begins with an A through G, use extension is 3133; if your last name begins with an H through O, use extension is 3110; if your last name begins with P through Z, use extension 3130. A favorable evaluation by ENER will result in issuance of a “Letter of Eligibility.” Eligible Air Force officers are competitively selected to fill specific program quotas by the Air Force Personnel Center. Other academically qualified Department of Defense-sponsored personnel are selected for attendance in accordance with their agency's guidelines. Academically qualified civilian applicants are admitted directly into the LSCMGT program.

4.1.5 CURRICULUM DESCRIPTION

The LSCMGT program is conducted in six academic quarters and a short term (18 total months) for DOD-sponsored full-time students. The short term provides a review of basic mathematics.

The minimum curriculum satisfying the degree requirements consists of 3 management core courses, 2 courses from an approved specialty sequence, 5 core courses in logistics and supply chain management, and 15 hours of research (to include a course in research methods and 12 hours of thesis research). The management core courses provide a wide variety of quantitative and qualitative concepts concerned with the many facets of integrated logistics management. The core courses in logistics and supply chain management ensure that all graduates have a basic foundation in the functions of transportation and inventory management and broaden the student’s knowledge base into the entire supply chain. Electives are offered in addition to strict degree requirements and broaden the student's horizons and/or provide more in-depth knowledge in a specific area of interest. Electives may also be required by the thesis advisor in order to adequately complete the required thesis research. The student’s research must address a real-world logistics problem. Principal purposes of the research thesis are to demonstrate the student's ability to integrate concepts and techniques acquired through course work and to demonstrate scholarly pursuit of a research question. Typically, thesis topics are sponsored by Air Force and Department of Defense agencies interested in student research in areas of practical concern.

4.1.5.1 BUSINESS FOUNDATION COURSES. Each student who graduated with a Master of Science in Logistics and Supply Chain Management must have a foundation in the theoretical and applied aspects of business. It is the faculty advisor’s responsibility to identify those students who, based on their undergraduate transcript and discussions with the student, have a deficiency in any of these areas.

Students identified with a deficiency are expected to fulfill this requirement. Deficiencies include:

Applied Statistics (Probability and Distributions)
Organization and Management Theory

If a student can demonstrate successful completion of a similar course in an undergraduate program (or previous graduate program) a waiver may be granted.
### 4.1.5.2 Logistics & Supply Chain Management Core Requirements

All students are required to have a fundamental understanding of logistics and supply chain management. This objective is accomplished through the following core courses:

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation Systems and Strategic Mobility (LOGM 617)</td>
<td>4</td>
</tr>
<tr>
<td>Inventory Management (LOGM 570)</td>
<td>4</td>
</tr>
<tr>
<td>Maintenance and Production Management (LOGM 569)</td>
<td>4</td>
</tr>
<tr>
<td>Strategic Sourcing (LOGM 565)</td>
<td>4</td>
</tr>
<tr>
<td>Maintenance and Sustainment (LOGM 612)</td>
<td>4</td>
</tr>
</tbody>
</table>

### 4.1.5.3 Management Core Requirements

To qualify for the Master of Science in Logistics and Supply Chain Management degree, all students must develop a foundation in fundamental management and quantitative logistics methods and associated disciplines. This objective is accomplished through the following management core course requirements:

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principles and Methods of Research (LOGM 601)</td>
<td>4</td>
</tr>
<tr>
<td>Business Analytics I (OPER 505)</td>
<td>4</td>
</tr>
</tbody>
</table>

### 4.1.5.4 Specialty Sequence Requirement

The required courses for each of the specialty tracks are as follows:

**Operational Logistics (OL)**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>Transportation Policy and Strategic Mobility (LOGM 619)</td>
<td>4</td>
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<tr>
<td>Forecasting Management (LOGM 630)</td>
<td>4</td>
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</tbody>
</table>

**Operational Maintenance (OM)**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>Scheduling: Theory and Application (LOGM 631)</td>
<td>4</td>
</tr>
<tr>
<td>Reliability, Maintainability, Supportability (LOGM 634)</td>
<td>4</td>
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</table>

**Petroleum Management (PM)**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
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<tr>
<td>Forecasting Management (LOGM 630)</td>
<td>4</td>
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<tr>
<td>Seminar in Petroleum Management (LOGM 651)</td>
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**Life Cycle Logistics (LC)**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credit Hours</th>
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<tr>
<td>Assessing Operational Cost and Risk (OPER 638)</td>
<td>3</td>
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<tr>
<td>Forecasting Management (LOGM 630)</td>
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</table>

**Nuclear Logistics Management (NL)**

<table>
<thead>
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<th>Course Title</th>
<th>Credit Hours</th>
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<tr>
<td>Policy and Strategy of Nuclear Weapons Employment (NENG 500)</td>
<td>4</td>
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<tr>
<td>Reliability, Maintainability, and Supportability (LOGM 634)</td>
<td>4</td>
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</tbody>
</table>
4.1.5.5 RESEARCH REQUIREMENT. Effective logistics and supply chain managers must be able to structure a problem, integrate analytical techniques, apply current technical literature, and communicate insights. Students refine these skills through 12-quarter hours of independent study, culminating in the submission and oral defense of a major research report (thesis). Detailed information on thesis objectives, requirements, and evaluation is available in the Department of Operational Sciences’, Policy on Master's Thesis Research.

4.1.5.6 TOTAL CREDIT HOURS. In addition to degree requirements, all DOD-sponsored full-time students must complete an average of 12 credit hours of study per quarter over the six quarters in residence.
4.1.6 SPECIALTY SEQUENCES: MASTER OF SCIENCE OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

GRADUATE LOGISTICS AND SUPPLY CHAIN MANAGEMENT -

Specialty Sequence: Operational Logistics - OL
Catalog Years 2018-2024  (Suggested six-quarter program for the full-time student)

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<td></td>
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<td>SPRING</td>
<td>LOGM 570</td>
<td>Principles of Inventory Management</td>
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<td>LOGM 612</td>
<td>Maintenance and Sustainment</td>
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72 Total Credit Hours
## GRADUATE LOGISTICS AND SUPPLY CHAIN MANAGEMENT

### Specialty Sequence: Operational Maintenance - OM
Catalog Years 2018-2024  (Suggested six-quarter program for the full-time student)

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| OPER 505             | 4            | ENS  |
| STAT 525             | 4            | ENC  |
| LOGM 617             | 4            | ENS  |
| LOGM 569             | 4            | ENS  |

| **WINTER**           |              |      |
| LOGM 520             | 4            | ENS  |
| LOGM 565             | 4            | ENS  |
| LOGM 601             | 4            |      |

| **SPRING**           |              |      |
| LOGM 570             | 4            | ENS  |
| LOGM 612             | 4            | ENS  |
| LOGM 634             | 4            | ENS  |

| **SUMMER**           |              |      |
| LOGM 620             | 4            | ENS  |
| XXXX                 | 4            |      |
| LOGM 799             | 3            | ENS  |

| **FALL**             |              |      |
| LOGM 799             | 3            | ENS  |
| LOGM 631             | 4            | ENS  |
| LOGM 682             | 4            | ENS  |

| **WINTER**           |              |      |
| LOGM 799             | 6            | ENS  |
| LOGM 542             | 4            | ENS  |

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72 Total Credit Hours
## GRADUATE LOGISTICS AND SUPPLY CHAIN MANAGEMENT
### Specialty Sequence: Petroleum Management - PM
Catalog Years 2018-2024  (Suggested six-quarter program for the full-time student)

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³ Normal electives for the Petroleum Management track are ENVR 511 (Environmental Management and Policy) and SENG 520 (Systems Engineering Design). Deviations must be approved by the Program Advisor
**GRADUATE LOGISTICS AND SUPPLY CHAIN MANAGEMENT**

**Specialty Sequence: Life Cycle Logistics - LC**

Catalog Years 2018-2024  (Suggested six-quarter program for the full-time student)

<table>
<thead>
<tr>
<th>Semester</th>
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70 Total Credit Hours
GRADUATE LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Specialty Sequence: Nuclear Logistics Management - NL
Catalog Years 2018-2024  (Suggested six-quarter program for the full-time student)

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<tr>
<td>STAT 525</td>
<td>Applied Statistics for Managers</td>
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<tr>
<td>LOGM 617</td>
<td>Transportation Systems and Strategic Mobility</td>
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<tr>
<td>LOGM 569</td>
<td>Maintenance and Production Management</td>
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<tr>
<td>LOGM 520</td>
<td>Managerial Economics</td>
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<td>LOGM 565</td>
<td>Strategic Sourcing</td>
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<td>LOGM 601</td>
<td>Principles and Methods of Research</td>
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<td>LOGM 570</td>
<td>Principles of Inventory Management</td>
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<td>LOGM 612</td>
<td>Maintenance and Sustainment</td>
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<td>LOGM 634</td>
<td>Reliability, Maintainability, Supportability</td>
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<tr>
<td>LOGM 620</td>
<td>Activity Based Costing/Management</td>
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<td>NENG 500</td>
<td>Policy &amp; Strategy of Nuclear Weapon Employment</td>
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<td>LOGM 799</td>
<td>Thesis Research</td>
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<td>LOGM 682</td>
<td>Business Analytics II</td>
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<tr>
<td>LOGM 799</td>
<td>Thesis Research</td>
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<tr>
<td>LOGM 542</td>
<td>Management of Logistics Organizations</td>
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</table>

72 Total Credit Hours
4.1.7. PEOS AND POS: MASTER OF SCIENCE IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Program Educational Objectives (PEOs)

Our Program Educational Objectives (expectations two or more years beyond graduation) are to produce graduates who:

1. **Breadth.** Apply foundational logistics concepts and sound analytical principles to efficiently and effectively advance Air Force, DoD, and other employer logistics and supply chain management capabilities.

2. **Depth.** Are well educated, highly-valued, and successful logisticians and supply chain experts.

3. **Professionalism.** Professionally communicate technical solutions and results.

4. **Lifelong Learning.** Continue to pursue lifelong multidisciplinary learning.

Program Outcomes (POs)

Our Program Outcomes (student knowledge/skills/abilities upon graduation) produce graduates who:

1. **Critical thinking skills.** Can critically analyze situations, information, and data.

2. **Problem solving skills.** Can formulate problem statements, ascertain and collect the relevant data, and utilize the correct methodology in order to both delineate and solve problems in the real world.

3. **Communication skills.** Can effectively communicate to peers, subordinates, and supervisors in a professional manner both orally and in writing.

4. **Logistics specific knowledge.** Have developed a thorough understanding of the logistics, mobility, and supply chain discipline as required to make strategic level managerial decisions in the logistics area.
4.2 MASTER OF SCIENCE IN OPERATIONS RESEARCH

4.2.1 THE DEGREE

The Commander, Air University, is authorized by Public Law 733 of the 83d Congress to confer degrees upon persons who meet all requirements for those degrees as established by AFIT. The Institute is accredited by the North Central Association of Colleges and Schools through the doctoral level. The Master of Science in Operations Research (OR.MS) program leads to the degree of Master of Science in Operations Research.

4.2.2 THE PROGRAM

The in-residence OR.MS program requires 18 months (6 academic quarters) of full-time study and begins in August of each year; however, part-time study is also possible. The program is directed by the Department of Operational Sciences of the Graduate School of Engineering and Management (AFIT/ENS), 2950 Hobson Way, Bldg 641, Wright-Patterson AFB, OH 45433-7765 (DSN 785-3636 ext. 2549, Commercial 937-255-3636 ext. 2549). The purpose of the program is to educate qualified military members and US citizen civilians in the theory and practice of operations research, with emphasis on the application of quantitative analysis techniques to defense decision-making.

Specific topics of study include mathematical modeling, decision analysis, simulation, statistical analysis, and optimization. The program is continuously reviewed by the users of program graduates, including Headquarters Air Staff, Studies and Analyses, Assessments, and Lessons Learned (HQ USAF/A9, the Air Force Operational Test and Evaluation Center, and Major Command analysis groups. The program is also open to qualified Department of Defense (DoD) civil service employees and other non-DoD US citizens.

4.2.3 PROGRAM GRADUATES

Graduates are typically assigned to analysis groups at the Pentagon, MAJCOM headquarters, AFMC product centers, or other DoD agencies. Non-operational Air Force officer graduates normally carry a 61A specialty code (analytical scientist) while operational officers come from the pilot, navigator, missile, and communications career fields. The program leads to the award of an education code of 0YEY, 0YEA, 0YEC, 0YET, 0YSY, 6EDY, 6EMY, or 6EOY. Army graduates are normally assigned to MAJCOMs, HQ DA, or various joint commands as FA49 or FA57 officers.

4.2.4 THE DISCIPLINE

Operations Research is the discipline of applying advanced analytical methods to help make better decisions. It provides a rational basis for decision making by seeking to understand and structure complex situations and to use this understanding to predict system behavior and improve system performance. Much of this work is done using analytical and numerical techniques to develop and manipulate mathematical and computer models of organizational and operational systems composed of people, equipment, and procedures. Operations Research draws upon ideas
from engineering, management, mathematics, and psychology to contribute to a wide variety of application domains; the field is closely related to several other fields in the decision sciences: applied mathematics, decision analysis, computer science, economics, industrial engineering, and systems engineering. Operations Research is distinguished by its broad applicability, and by the wide variety of career opportunities and work styles it embraces. Within the field, some Operations Research professionals remain generalists while others specialize in particular tools or problem domains.

4.2.5 ADMISSION CRITERIA AND PROCEDURES

The educational prerequisite for admission to the OR program is a baccalaureate degree in operations research, mathematics (not math education), engineering, physics, computer science, or quantitative economics, or other quantitative discipline, provided in each case that curriculum includes sufficient mathematics. Mathematics prerequisites include calculus I and II (integral and differential calculus) and an advanced calculus course (e.g. multivariable calculus). The minimum undergraduate grade-point-average (GPA) is 3.00 out of 4.00 for all coursework. All applicants must take the Graduate Record Examination (GRE); minimum acceptable GRE scores are at least 153 (verbal) and 148 (quantitative) on the Education Testing Service (ETS) 2012 GRE Concordance Table (which is based upon performance of all examinees who tested between 1 August 2011 and 30 April 2012); or at least 500 (verbal) and 600 (quantitative) for GRE tests taken/scored under the old scale ETS used prior to August 2011 test dates.

Waivers to these requirements can be requested through the AFIT Admissions Office.

Potential applicants may submit a request for evaluation of eligibility at any time. The request should be submitted to the AFIT Admissions Office (AFIT/ENER), 2950 Hobson Way, Wright-Patterson AFB, OH 45433-7765 (DSN 785-6234, x3184, Commercial 937-255-6234, x3184). A favorable evaluation by ENER will result in issuance of a “letter of academic eligibility”. Eligible Air Force officers are competitively selected to fill specific program quotas by the Air Force Personnel Center.

4.2.6 CURRICULUM DESCRIPTION

4.2.6.1 PREREQUISITE COURSES. There are no specified perquisite courses assuming a student meets the minimum admission criteria; however, in some cases, students are given specific prerequisite courses prior to beginning the core requirements in order to provide necessary background in fundamental operations research areas, as well as mathematics and statistics foundations. A four-week short term is provided prior to the first academic quarter in order to review basic computer programming, mathematics, statistics, and operations research concepts.

4.2.6.2 CORE REQUIREMENTS. To qualify for the Master of Science in Operations Research degree, all OR.MS students must develop a foundation in fundamental operations research methods (decision analysis, optimization, simulation, statistical analysis, and stochastic modeling), and associated disciplines (economics and mathematics). This objective is accomplished through satisfaction of the following core course requirements:
Mathematics

Numerical Analysis and Applied Linear Algebra (MATH 521) 4

Decision Analysis

Decision Analysis using VFT (OPER 542) 4

Deterministic Operations Research

Introduction to Mathematical Programming (OPER 510) 4
Linear Programming (OPER 610) 3

Simulation

Discrete-Event Simulation (OPER 561) 4

Applied Statistics

Applied Probability and Statistical Analysis (STAT 587) 4
Empirical Modeling (OPER 679) 3
Applied Multivariate Analysis I (OPER 685) 3

Probabilistic Operations Research

Stochastic Modeling and Analysis I (OPER 540) 4

Electives

3

Students who have previously taken comparable graduate courses may request action through their faculty advisor for transfer credit or waiver of specific courses. Under appropriate circumstances, course substitutions may be approved by the ENS Department Head. In addition to these core requirements all full time U.S. active duty military students must also take the following courses (each 3 credit hours):

Operational Decision Support Systems (OPER 544/544L)
Assessing Operational Cost and Risk (OPER 638)
Issues in Defense Analysis (OPER 695)

4.2.6.3 INDEPENDENT STUDY (THESIS RESEARCH) REQUIREMENT. Effective operations research analysts must be able to structure a problem, integrate analytical techniques, apply current technical literature, and communicate insights. Students refine these skills through a minimum of 12 quarter-hours of independent study in the area of Operations Research, culminating in the submission and oral defense of a major research report (thesis). Detailed information on thesis objectives, requirements, and evaluation is available in the ENS document, Policy on Master's Thesis Research (see Appendix D).

4.2.6.4 ELECTIVE SPECIALTY SEQUENCE. In addition to the core requirements, all OR.MS students are encouraged to develop in-depth knowledge in at least one specialty area. The specialty sequence consists of at least three courses selected from one of the listed specialty
areas (described below). Students who do not select Operational Modeling as their specialty are encouraged to take at least one elective in the Operational Modeling emphasis area. Courses within a specialty area may be substituted with the approval of the Head of the Department of Operational Sciences. Students that meet specialty area course requirements will have the respective specialization indicated on their AFIT transcript.

**Deterministic Operations Research**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>OPER 612</td>
<td>Nonlinear Programming</td>
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<td>OPER 613</td>
<td>Integer Programming</td>
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<td>OPER 614</td>
<td>Dynamic Programming</td>
</tr>
<tr>
<td>OPER 615</td>
<td>Large Scale Systems Optimization</td>
</tr>
<tr>
<td>OPER 617</td>
<td>Networks</td>
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<td>OPER 621</td>
<td>Multicriteria Optimization</td>
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<td>OPER 623</td>
<td>Heuristic Search Methods</td>
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<td>Scheduling Theory</td>
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<td>OPER 710</td>
<td>Advanced Linear Programming and Extensions</td>
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<td>OPER 713</td>
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**Probabilistic Operations Research**

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<tbody>
<tr>
<td>OPER 614</td>
<td>Dynamic Programming</td>
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<td>OPER 641</td>
<td>Stochastic Modeling and Analysis II</td>
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<tr>
<td>OPER 647</td>
<td>Queueing System Analysis</td>
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<td>OPER 746</td>
<td>Advanced Topics in Reliability</td>
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<td>STAT 687</td>
<td>Mathematics of Reliability Theory I</td>
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**Simulation**

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<td>OPER 661</td>
<td>Statistical Aspects of Simulation: Output Analysis</td>
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<tr>
<td>OPER 671</td>
<td>Combat Modeling</td>
</tr>
<tr>
<td>OPER 683</td>
<td>Response Surface Methodology</td>
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<tr>
<td>OPER 785</td>
<td>Applied Multivariate Analysis II: Pattern Recognition</td>
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**Decision Analysis**

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<td>OPER 621</td>
<td>Multicriteria Optimization</td>
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<tr>
<td>OPER 638</td>
<td>Assessing Operational Cost and Risk</td>
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<td>OPER 642</td>
<td>Decision Analysis under Uncertainty and Risk</td>
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<tr>
<td>OPER 743</td>
<td>Decision Analysis Practice</td>
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**Applied Statistics**

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<td>OPER 661</td>
<td>Statistical Aspects of Simulation: Output Analysis</td>
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<td>OPER 681</td>
<td>Statistical Process Control</td>
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<tr>
<td>OPER 683</td>
<td>Response Surface Methodology</td>
</tr>
<tr>
<td>OPER 684</td>
<td>Quantitative Forecasting Techniques</td>
</tr>
<tr>
<td>OPER 688</td>
<td>Operational Experimentation</td>
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</table>
Information Operations / Information Warfare (IO/IW)
CSCE 525 Introduction to Information Warfare
OPER 617 Networks
OPER 671 Combat Modeling
OPER 676 Information Operations Research (required)
OPER 743 Decision Analysis Practice

Operational Modeling
NENG 597 Nuclear Weapon Effects, Technology, and Non-proliferation
OPER 671 Combat Modeling
OPER 674 Joint Mobility Modeling
OPER 676 Information Operations Research
OPER 695 Issues in Defense Analysis
SENG 564 Conventional Weapons Effects

4.2.6.5 EMPHASIS STUDY AREAS.

Full-time students may wish to augment their education plan with elective courses provided a specific emphasis. These emphasis areas are suggested courses used as electives. Typically, these would be used for students desiring specific background for future analytical positions.

Logistics Analysis (3 of the 4 suggested)
LOGM 570 Principles of Inventory Management
LOGM 617 Transportation Systems and Strategic Mobility
LOGM 627 Supply Chain Management
LOGM 634 Reliability, Maintainability, and Supportability

Space Systems Analysis
EENG 571 Satellite Communications
PHYS 521 Space Surveillance
SENG 520 Systems Engineering Design

4.2.6.6 EDUCATION PLAN AND OTHER ELECTIVES.

All AFIT students must complete an approved program of study, formulated with a faculty advisor and documented in an education plan (Ed Plan). In accordance with ENOI 36-120, dated 29 May 2012, degree seeking students are responsible for maintaining the currency and accuracy of their Ed Plans. The Ed Plan must be approved before the end of the first quarter of study and should be reviewed by the student prior to each subsequent quarter course registration. The elements of the OR.MS program are summarized above and a typical course schedule (quarter-by-quarter sequence) is provided below. Students must coordinate their electives with their faculty advisor and independent study advisor (i.e., thesis advisor).
4.2.7 ADDITIONAL STANDARDS FOR DOD FULLY-FUNDED STUDENTS

A program of study (Ed Plan) for DoD fully-funded OR.MS students normally includes the following areas:

Seminars

Students are expected to enroll in the operations research seminar (OPER 500) during Fall, Winter, and Summer quarters. These seminars provide a forum to acquaint students with current operations research practice in the Air Force and DoD analysis communities, state-of-the-art research within the operations research discipline, as well as faculty research interests. Seminars are also used for lectures by distinguished visitors and prominent speakers. In addition, full-time students take OPER 498 (Research Methods) for guidance in the completion of thesis research and technical writing and reviewing.

Total Credit Hours

All DoD fully-funded, full-time students are expected to carry an average course load of 12 credit hours per quarter. Hence, students enrolled in a six-quarter program should accumulate at least 72 hours (excluding short term courses and TENS courses). A minimum of 12 additional graded graduate coursework hours are required beyond the 48 minimum hours (core and thesis research) required for the degree. For all students, extra graded graduate hours are used as an element in determining distinguished graduates (DGs). If properly selected with your faculty and independent study advisor, up to 12 of these credit hours may be applied to the AFIT/ENS Operations Research PhD program.

Students are required to have an education plan approved by an academic advisor prior to (pre-) registering for courses each term.

4.2.8 ACQUISITION PROFESSIONAL DEVELOPMENT PROGRAM (APDP)

OR.MS students who are pursuing acquisition careers in Systems Planning, Research, Development, and Engineering (SPRDE) and other functional areas will normally satisfy all educational requirements for APDP certification through Level III. SPRDE educational requirements include the following:

- A baccalaureate degree in engineering, physics, chemistry, mathematics, or related field
- At least nine quarter hours in quantitative methods (satisfied by OR.MS core courses)
- At least nine quarter hours (undergraduate or graduate) in accounting, business finance, law, contracts, purchasing, economics, industrial management, marketing, or organizational management. If necessary, students may select appropriate electives to complete this requirement.

4.2.9 COURSE SEQUENCE: MASTER OF SCIENCE IN OPERATIONS RESEARCH

(Suggested six-quarter program for the full time student)
<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Code</th>
<th>Course Title</th>
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<td>MATH 002 &amp; 004</td>
<td>Calculus and Linear Algebra Review</td>
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<td>OPER 200</td>
<td>Computer Programming Review</td>
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<td>OPER 300</td>
<td>Introduction to Operations Research</td>
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<td>ENS</td>
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<td>OPER 400</td>
<td>Probability and Statistics Review</td>
<td>0</td>
<td>ENS</td>
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<tr>
<td>FALL</td>
<td>MATH 521</td>
<td>Applied Linear Algebra</td>
<td>4</td>
<td>ENC</td>
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<tr>
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<td>STAT 587</td>
<td>Applied Probability and Statistical Analysis</td>
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<td>ENC</td>
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<td>OPER 510</td>
<td>Introduction to Mathematical Programming</td>
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<td></td>
<td>OPER 540</td>
<td>Stochastic Modeling and Analysis I</td>
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<td>Decision Analysis using VFT</td>
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<td>ENS</td>
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<tr>
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<td>Linear Programming</td>
<td>3</td>
<td>ENS</td>
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<tr>
<td>SPRING</td>
<td>OPER 498</td>
<td>Research Methods</td>
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<td>OPER 561</td>
<td>Discrete Event Simulation</td>
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<td>OPER 679</td>
<td>Empirical Modeling</td>
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<td>OPER 685</td>
<td>Applied Multivariate Analysis I</td>
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<td>OPER 544L***</td>
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<tr>
<td></td>
<td>OPER 695***</td>
<td>Issues in Defense Analysis</td>
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</tbody>
</table>
** Undergraduate Credit

** TENS 799 Thesis Completion - This is not a course in the Graduate Catalog and will not appear on a transcript. Students must, however, register for 12 credit hours of TENS 799 in order for their thesis completion, final thesis grade, and 12 thesis credit hours to post to their transcript.

*** Course required for full-time U.S. active duty military students

This program is intended to be typical for a full-time student.

4.2.10 PEOS AND POS: MASTER OF SCIENCE IN OPERATIONS RESEARCH

Program Educational Objectives (PEOs)

Our Program Education Objectives (expectations two or more years beyond graduation) are to produce graduates who:

1. **Breadth.** Apply foundational operations research analysis techniques to efficiently and effectively advance Air Force, DoD, and other government inter-agency organizations, as well as other employer capabilities.

2. **Depth.** Are well educated, highly-valued, and successful operations research analysts.

3. **Professionalism.** Professionally communicate technical analytical assessments, solutions, and results.

4. **Lifelong Learning.** Continue to pursue lifelong multidisciplinary learning.

Program Outcomes (POs)

Our Program Outcomes (student knowledge/skills/abilities) produce graduates who:

1. **Critical thinking and problem solving skills.** Have the ability to classify, formulate, and solve operations research problems.

2. **Operations research specific knowledge.** Have knowledge of operations research areas such as probabilistic modeling, applied statistics, mathematical programming, simulation, and decision analysis to directly support decision and policy making activities.
3. **Communication Skills.** Develop written and oral communications skills necessary to present complex problems to a decision-making audience: problem definition, modeling methodologies, including solution advocacy that utilizes rigorous analytical support.
4.3 MASTER OF SCIENCE IN LOGISTICS

4.3.1 THE DEGREE

The Commander, Air University, is authorized by Public Law 733 of the 83d Congress to confer degrees upon persons who meet all requirements for those degrees as established by AFIT. The Institute is accredited by the North Central Association of Colleges and Schools through the doctoral level. This specific program (LOGSCI.MS) leads to the degree of Master of Sciences in Logistics.

4.3.2 THE PROGRAM

Primarily for DoD-sponsored full-time students or part-time students, the LOGSCI program requires 12 months (4 academic quarters) of full-time study or 36 months (12 academic quarters) of part-time distance-learning-based study beginning in January of each year. Only those DoD-sponsored students selected in-residence may participate in the full-time program and only those DoD sponsored students selected for the distance-learning track may participate in the part-time program. The program is directed by the Department of Operational Sciences (AFIT/ENS), Graduate School of Engineering and Management, 2950 Hobson Way, Bldg 641, Wright-Patterson AFB, OH 45433-7765 (DSN 785-2549, Commercial 937-255-2549).

4.3.3 PROGRAM GRADUATES

Graduates will be well-prepared to fill a variety of key decision-making, and policy formulation positions at the Pentagon, MAJCOM headquarters, COCOM headquarters, AFMC product centers, operational units, and other DoD agencies.

4.3.4 ADMISSION CRITERIA AND PROCEDURES

The general requirements for admission to the LOGSCI.MS program in the Department of Operational Sciences are:

1. A baccalaureate degree or equivalent.
2. A cumulative undergraduate GPA of 3.00 (on a 4.00 scale).
3. Graduate Management Admissions Test (GMAT) score of at least 550; or Graduate Records Examination (GRE) of at least 153 (verbal) and 148 (quantitative) on the Education Testing Service (ETS) 2012 GRE Concordance Table (which is based upon performance of all examinees who tested between 1 August 2011 and 30 April 2012); or at least 500 (verbal) and 600 (quantitative) for GRE tests taken/scored under the old scale ETS used prior to August 2011 test dates.
4. College algebra with a grade of B or higher.
5. Board selected for in-residence or distance-learning program.

Waivers to the above requirements may be granted on an individual basis by the Department of Operational Sciences. Admission procedures are specified in the AFIT home page at http://www.afit.edu/ADMISSIONS/.
4.3.5 CORE DEGREE REQUIREMENTS
The core courses required for the LOGSCI.MS program are: LOGM 520, LOGM 542, LOGM 570, LOGM 601, LOGM 617, LOGM 620, and then (LOGM 565 and LOGM 568 and LOGM 569) for DL students or (LOGM 567 and LOGM 660) for in-residence students. These courses provide the student with a functional base from which they will best understand the logistics field.

4.3.5.1 TOOLS COURSES. LOGSCI/MS students shall take two (2) tools classes to familiarize them with some of the various tools needed to manage and conduct research in the logistics and supply chain field. Those courses are STAT 521 and OPER 501.

4.3.5.2 CAPSTONE COURSE. All LOGSCI.MS students shall take a capstone course in their final quarter to integrate all the material learned while attending AFIT. The LOGSCI.MS capstone course is LOGM 627.

4.3.5.3 RESEARCH PROJECT. All students are required to complete a research or design project under the direction of a faculty advisor. This project requirement provides an introduction to the research process, strengthens the student's writing skills, and augments the AFIT research program. It is intended for students to apply the processes, methods, and tools, acquired throughout their academic program, to a relevant DoD war fighting problem. The project is documented in an advisor approved format and defended orally. Students will take 8 course hours of LOGM 791.

4.3.6 EDUCATIONAL PLANS AND COURSE SUBSTITUTIONS
All AFIT students must complete an approved program of study, formulated with a faculty advisor and documented in an education plan (Ed Plan). In accordance with ENOI 36-120, dated 29 May 2012, degree seeking students are responsible for maintaining the currency and accuracy of their Ed Plans. The Ed Plan must be approved before the end of the first quarter of study and should be reviewed by the student prior to each subsequent quarter course registration. Courses may be substituted in the following curriculum with the approval of the LOGSCI.MS Program Director.

4.3.7 SAMPLE COURSE SEQUENCE*: MASTER OF LOGISTICS SCIENCES (DISTANCE-LEARNING TRACK – COURSE ORDER AND OFFERINGS WILL CHANGE ANNNUALLY)

<table>
<thead>
<tr>
<th>YEAR 1</th>
<th>Credit Hours</th>
<th>Dept</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOGM 569</td>
<td>4</td>
<td>ENS</td>
</tr>
<tr>
<td>LOGM 612</td>
<td>4</td>
<td>ENS</td>
</tr>
<tr>
<td>OPER 505</td>
<td>4</td>
<td>ENS</td>
</tr>
<tr>
<td>STAT 525</td>
<td>4</td>
<td>ENC</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>YEAR 2</th>
<th>Credit Hours</th>
<th>Dept</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOGM 565</td>
<td>4</td>
<td>ENS</td>
</tr>
<tr>
<td>LOGM 617</td>
<td>4</td>
<td>ENS</td>
</tr>
<tr>
<td>LOGM 601</td>
<td>4</td>
<td>ENS</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>LOGM 620</td>
<td>Activity Based Costing/Management</td>
<td>4</td>
</tr>
</tbody>
</table>

**YEAR 3**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOGM 542</td>
<td>Management of Logistics Organizations</td>
<td>4</td>
<td>ENS</td>
</tr>
<tr>
<td>LOGM 570</td>
<td>Principles of Inventory Management</td>
<td>4</td>
<td>ENS</td>
</tr>
<tr>
<td>LOGM 791</td>
<td>Research Project for Operational Sciences</td>
<td>8</td>
<td>ENS</td>
</tr>
<tr>
<td>PENS 791**</td>
<td>Research Project Completion</td>
<td>N/A</td>
<td>ENS</td>
</tr>
</tbody>
</table>

16

48 Total Credit Hours

*Course sequence may change due to course availability.

** PENS 791 Research Project Completion - This is not a course in the Graduate Catalog and will not appear on a transcript. Students must, however, register for 8 credit hours of PENS 791 in order for their graduate research project completion, final GRP grade, and the 8 GRP credit hours to post to their transcript.

4.3.8 PEOS AND POS: MASTER OF SCIENCE IN LOGISTICS

**Program Educational Objectives (PEOs)**

Our Program Educational Objectives (expectations two or more years beyond graduation) are to produce graduates who:

1. **Breadth.** Apply foundational logistics concepts and sound analytical principles to efficiently and effectively advance Air Force and DoD logistics capabilities.

2. **Depth.** Are well educated, highly-valued, and successful logisticians.

3. **Professionalism.** Professionally communicate technical solutions and results.

4. **Lifelong Learning.** Continue to pursue lifelong multidisciplinary learning.

**Program Outcomes (POs)**

Our Program Outcomes (student/knowledge/skills/abilities upon graduation) produce graduates with:

1. **Critical thinking skills.** Can critically analyze situations, information, and data.

2. **Problem solving skills.** Can formulate problem statements, ascertain and collect the relevant data, and utilize the correct methodology in order to both delineate and solve problems in the real world.
3. **Communication skills.** Can effectively communicate to peers, subordinates, and supervisors in a professional manner both orally and in writing.

4. **Logistics specific knowledge.** Have developed a thorough understanding of the logistics, mobility, and supply chain discipline as required to make strategic level managerial decisions in the logistics area.
4.4 MASTER OF SCIENCE IN OPERATIONS MANAGEMENT

4.4.1 THE DEGREE

The Commander, Air University, is authorized by Public Law 733 of the 83d Congress to confer degrees upon persons who meet all requirements for those degrees as established by AFIT. The Institute is accredited by the North Central Association of Colleges and Schools through the doctoral level. The Graduate Operations Management (OPSMGMT) program leads to a degree of Master of Science in Operations Management.

4.4.2 THE PROGRAM

The OPSMGMT program is the formal graduate study portion for various Intermediate Developmental Education (IDE) programs in the US Air Force. The goal of the OPSMGMT program is to cultivate a core of officers with an in-depth education in operations management, quantitative decision making, and critical thinking skills to lead the Air Force in the future. The IDE programs consist of the degree granting portion, plus additional professional development courses combined with trips to joint and major commands around the globe. As such, this enhances the AFIT degree portion of the IDE program, providing the military with a professional, degree-granting program, similar to executive management degree programs in civilian institutions. The curriculum consists of eight core courses in the areas of operations management, process improvement, organizational management, quantitative decision making, and research methods. The remainder of the curriculum is tailored for each of the IDE programs using specialty tracks. Each specialty track has between 18-19 hours of electives available to complete the degree requirements for the program. Courses are taught individually in a compressed schedule. The program also requires a graduate research paper that examines a topic pertaining to the operational Air Force. Each program will be 12 months long (four academic quarters) and will involve a Permanent Change of Station (PCS) to various locations, depending on the particular IDE program. Class size is limited to 16 students. Students typically come from operational and support AFSCs in the Air Force.

4.4.3 PROGRAM GRADUATES

Graduates are typically assigned to the Air Staff, a Major Command, or a Combatant Command. The Advanced Academic Degree (AAD) code is 1AKZ. The Air Force Specialty Codes in which graduates are normally assigned will vary based on the specialty track.

4.4.4 ADMISSION CRITERIA AND PROCEDURES

The general requirements for admission to the OPSMGMT program in the Department of Operational Sciences are:

1. A baccalaureate degree or equivalent.
2. A cumulative undergraduate GPA of 3.00 (on a 4.00 scale).
3. Graduate Management Admissions Test (GMAT) score of at least 550; or Graduate Records Examination (GRE) of at least 153 (verbal) and 148 (quantitative) on the Education Testing Service (ETS) 2012 GRE Concordance Table (which is based upon performance of all examinees who tested between 1 August 2011 and 30 April 2012); or at least 500 (verbal) and 600 (quantitative) for GRE tests taken/scored under the old scale ETS used prior to August 2011 test dates.
4. College algebra with a grade of B or higher.

Only students selected for in-residence IDE may be enrolled in the program.

Waivers to the above requirements may be granted on an individual basis by the Department of Operational Sciences.

4.4.5 GRADUATE RESEARCH PROJECT

All OPSMGMT students are required to complete a graduate research project under the direction of a faculty advisor. This independent study requirement (LOGM 791) provides an introduction to the research process, strengthens the student’s writing skills, and augments the AFIT/ENS research program, providing valuable research to the sponsor on an operationally relevant problem.

4.4.6 CORE DEGREE REQUIREMENTS

To receive the Master of Science in Operations Management degree, all OPSMGMT students must satisfactorily complete the following courses:

<table>
<thead>
<tr>
<th>Course Description</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate Research Project (LOGM 791)</td>
<td>7</td>
</tr>
<tr>
<td>Management (LOGM 545, 568, 613, IMGT 669, &amp; LOGM 569 or 636)</td>
<td>15</td>
</tr>
<tr>
<td>Research Foundation (LOGM 525, 601; OPER 501)</td>
<td>11</td>
</tr>
<tr>
<td>===</td>
<td></td>
</tr>
<tr>
<td>33 Total Credit Hours</td>
<td></td>
</tr>
</tbody>
</table>

Because of the unique nature of its delivery method and lack of alternative course offerings, students who have previously taken a comparable course may not request action to transfer credit, waiver, or substitute specific courses.

4.4.6.1 SPECIALTY SEQUENCE REQUIREMENT

The required courses for each of the specialty tracks are as follows:

<table>
<thead>
<tr>
<th>Logistics and Air Mobility (LOGAIR)</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint Mobility Modeling (OPER 674)</td>
<td>3</td>
</tr>
<tr>
<td>Transportation Systems and Strategic Mobility (LOGM 622)</td>
<td>3</td>
</tr>
<tr>
<td>Reliability, Maintainability, and Supportability (LOGM 639)</td>
<td>3</td>
</tr>
<tr>
<td>Air Transportation Management (LOGM 621)</td>
<td>3</td>
</tr>
<tr>
<td>Supply Chain Management Capstone (LOGM 626)</td>
<td>3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>15</td>
</tr>
</tbody>
</table>
### 4.4.7 NOTIONAL COURSE SEQUENCE – MASTER OF SCIENCE IN OPERATIONS MANAGEMENT (OPSMGMT)

#### SUMMER

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
<th>Dept</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOGM 525</td>
<td>Statistics for Mobility Managers</td>
<td>4</td>
<td>ENC</td>
</tr>
<tr>
<td>OPER 501</td>
<td>Quantitative Decisions Making</td>
<td>3</td>
<td>ENS</td>
</tr>
<tr>
<td>LOGM 568</td>
<td>Introduction to Supply Chain Management</td>
<td>3</td>
<td>ENS</td>
</tr>
<tr>
<td>LOGM 601</td>
<td>Principles and Methods of Research</td>
<td>4</td>
<td>ENS</td>
</tr>
</tbody>
</table>

**14 Grad Credit Hours**

#### FALL

- Elective Track Specific Course: 3
- IMGT 669  Business Process Improvement: 3 (ENV)
- Elective Track Specific Course: 3
- Elective Track Specific Course: 3

**12**

#### WINTER

- Elective Track Specific Course: 3
- LOGM 545 Introduction to Management and Organizations: 3 (ENS)
- Elective Track Specific Course: 3

**9**

#### SPRING

- LOGM 613 Transportation Policy and Strategic Mobility: 3 (ENS)
- Elective Track Specific Course: 3
- LOGM 791 Research Project for Operations Managers: 7 (ENS)
- PENS 791\(^3\) Research Project Completion: N/A (ENS)

**13**

Logistics and Air Mobility (LOGAIR) Track: 48 Total Credit Hours

The quarter shown reflects the quarter in which the course ends unless noted.

\(^3\) PENS 791 Research Project Completion - This is not a course in the Graduate Catalog and will not appear on a transcript. Students must, however, register for 7 credit hours of PENS 791 in order for their graduate research project completion, final GRP grade, and the 7 GRP credit hours to post to their transcript.
4.4.8 PEOS AND SLOS: MASTER OF SCIENCE IN OPERATIONS MANAGEMENT

Program Educational Objectives (PEOs)

Our Program Education Objectives (expectations two or more years beyond graduation) are to produce graduates who:

1. **Breadth.** Apply foundational managerial and leadership concepts and sound analytical principles to efficiently and effectively advance Air Force and DoD capabilities.

2. **Depth.** Are well educated, highly-valued, and successful officers within their respective career field.

3. **Professionalism.** Professionally communicate technical solutions and results.

4. **Lifelong Learning:** Continue to pursue lifelong multidisciplinary learning and to become a well-informed and well-educated consumer of analysis.

Student Learning Outcomes (SLOs)

Upon completion of the program, the student:

1. **Intellectual skills (analytic inquiry).** Disaggregates, adapts, reformulates, and employs in a paper or project principal ideas, techniques, or methods at the forefront of the field.

2. **Intellectual skills (quantitative fluency).** Articulates and undertakes multiple appropriate applications of quantitative methods, concepts and theories.

3. **Intellectual skills (communication fluency).** Creates sustained, coherent arguments or explanations and reflections on his/her work of that of collaborators (if applicable) in two or more media to both specialized and general audiences.

4. **Specialized knowledge.** Initiates, assembles, arranges, and reformulates ideas, concepts, designs, and techniques in carrying out a project directed at a challenge in the field beyond conventional boundaries.
CHAPTER 5: DOCTOR OF PHILOSOPHY DEGREE PROGRAM GUIDES

5.1. DOCTOR OF PHILOSOPHY IN LOGISTICS

5.1.1. THE DOCTOR OF PHILOSOPHY DEGREE

The Doctor of Philosophy (Ph.D.) degree entails completion of rigorous coursework requirements that prepare the student for advanced research and analysis in a chosen field of study. The doctoral degree is generally characterized as a research degree with substantial emphasis placed on the completion of the dissertation research. The degree has strong interdisciplinary support, with typical technical methods options in reliability, optimization, applied statistics, or systems engineering areas.

Close interaction between the student and his/her research advisory committee plays a pivotal role in the successful completion of the Ph.D. program. Equally important is the discipline and dedication of the student, as independent study is a critical element for timely program completion.

5.1.1.1. THE AIR FORCE INSTITUTE OF TECHNOLOGY PH.D. IN LOGISTICS

Doctoral study in Logistics provides a path for Air Force and Department of Defense (DoD) personnel (service members as well as civilians) to pursue advanced research topics in Logistics. Admission requirements for civilian or DoD students (full- or part-time) are the same. Non-Air Force quota DoD students do not affect the Air Force educational quotas outlined in Section 1.2. Limited Ph.D. Assistantships are available for qualified civilians. See Appendix A for details on Assistantships.

5.1.1.2. AIR FORCE QUOTA PERSONNEL

Air Force Ph.D. educational quotas have been established to satisfy three general categories of Air Force needs: (1) At-large quotas referred to as “Air Force sponsored,” (2) Pipeline instructor quotas with a commitment to join the AFIT faculty upon completion of the degree, and (3) U.S. Air Force Academy instructor quotas. This Ph.D. program supports at minimum Air Force education codes 1ACY, 1AMC, 1AMG, 1AMM, 1AMN, 1AMS, 1AMY, 1ATY, and 1CBF, (all in logistics areas).

Category (1) quotas provide logisticians for any Ph.D. assignments in the Air Force while the others are specifically geared toward faculty assignments. Applicants interested in either category (1) or category (2) should indicate their preference when they apply. Category (3) quotas are controlled by the U.S. Air Force Academy (USAFA), which sends selected faculty for a doctoral degree upon completion of an initial teaching assignment.

5.1.1.3. ELIGIBILITY AND ADMISSION REQUIREMENTS FOR THE PH.D. PROGRAM

To be considered for Ph.D. admission, an applicant must first establish eligibility by submitting an application for review of eligibility, including transcripts and Graduate Record
Examination (GRE) or Graduate Management Admission Test (GMAT) scores, to the AFIT Admissions Office (AFIT/ENER). Exceptions are made only for students currently enrolled in the master's programs in residence at AFIT who seek extension directly into the Ph.D. program. In such cases, the student submits a Change of Enrollment Status Form, available from the Registrar’s Office, which the Admissions Office forwards to the Logistics faculty who performs the eligibility screening. In addition to the requirements listed above, all applicants are required to submit a letter to the departmental point of contact for Applications and Personnel Matters (see end of this guide) summarizing their background and potential research interests. Additionally, each student must submit a short essay (no more than one page) describing his/her reasons for pursuing doctoral studies.

In accordance with the AFIT Doctoral Council Policy Letters, a student possessing a master's degree who seeks to enter a doctoral program must meet the following minimum requirements:

1. A quality bachelor’s degree with grades averaging at least 3.0 on a 4.0 scale
2. A quality master’s degree with grades averaging at least 3.5 on a 4.0 scale
3. Successful completion of a master’s thesis is very desirable
4. GRE scores of at least 156 (verbal) and 151 (quantitative) on the Education Testing Service (ETS) 2012 GRE Concordance Table (which is based upon performance of all examinees who tested between 1 Aug 2011 and 30 April 2012; or 550 (verbal) and 650 (quantitative) for GRE tests taken/scored under the old scale used by ETS prior to August 2011; or GMAT scores of at least 650.

Eligibility also requires background, education, and experience compatible with advanced graduate study in Logistics. (Typically, students entering the Ph.D. program will possess a M.S. degree in logistics, supply chain management, operations research, operations management, industrial engineering, or other relevant field.) All application packages are referred to the Logistics faculty of the Department of Operational Sciences for review and recommendation. Waivers to the above criteria may be granted on a case-by-case basis.

The student’s prior coursework should enable him/her to complete the Logistics core courses listed in Section 5.1.3.1, as well as the mathematics requirement described in Section 5.1.2.2. (Prospective students should contact the Department for an assessment if needed.) If a prospective student does not meet these requirements, remedial coursework (beyond the Ph.D. requirements) will be necessary. See Appendix B for information regarding the transfer of courses from a MS to the Ph.D. program. A complete listing of course descriptions for Logistics may be found in the course description section of the catalog at https://www.afit.edu/ENER/doclib.cfm?dl=31 beginning on page 186.

Each year, the AFIT Admissions Office forwards records of all applicants for the Ph.D. program to the Department of Operational Sciences for review. The Department considers this pool along with potential, in-resident master’s degree candidates at AFIT. Assessing the research potential of each candidate is an integral part of the evaluation process. The Department returns a prioritized list of active duty Air Force officer candidates to the Admissions Officer, who then forwards the list to the Air Force Personnel Center (AFPC). Final assignment decisions are made by AFPC. All other applications from U.S. citizens may be considered at any time. Once
eligibility has been established, the applicant is notified by letter. Likewise, AFPC is informed of the eligibility and, if applicable, the volunteer status of the candidate.

5.1.1.4. BACHELOR’S DEGREE ENTRY INTO THE PH.D. PROGRAM. This program allows exceptionally well-qualified students to pursue a Ph.D. directly from Bachelor degree programs. Participants in the program need to fulfill all the requirements of the Logistics M.S. program and those prescribed in this guide. These students are governed by the doctoral policy letter entitled Bachelor Entry to Ph.D. Program, approved 29 June 2007, policy letter #3 at https://www.afit.edu/ENS/doclib.cfm?dl=110.

This program requires significant advance planning for success. A Pro-Tem advisor will be appointed by the Head of the Department of Operational Sciences in consultation with the Ph.D. program director as far in advance of the beginning of the student’s program as is reasonable. The Pro-Tem advisor fills a wider role for this type of student as compared to an entering student with an appropriate M.S. degree. As prescribed in the policy letter, the Pro-Tem advisor is expected to be the M.S. thesis advisor and, subsequently, the Ph.D. research advisor as well. Hence, these students will be required to provide detailed information on their potential areas of research interest prior to the assignment of a Pro-Tem advisor.

5.1.2. AFIT PH.D. COURSEWORK REQUIREMENTS
The Department of Operational Sciences administers AFIT’s Ph.D. program in Logistics. Candidates are expected to take a track of logistics courses. Quarterly workload requirements are discussed in Appendix C. Requirements for the Ph.D. degree include 40 quarter-hours of coursework beyond the master's degree and a period of full-time research leading to successful completion of the doctoral dissertation. In addition to the Core courses (23 hours), the three required coursework areas are: (i) technical methods (6 hrs), (ii) mathematics requirement (8 hrs), and (iii) an elective (4 hrs). The technical methods and mathematics requirements are described in the subsections that follow.

5.1.2.1. TECHNICAL METHODS. The minimum 6 hours of technical methods area courses may consist of courses from more than one department as long as these courses form an integrated program designed to make the student an expert in the chosen area of research. In some cases this may require more than 6 hours. These specialty courses normally build on the individual student's MS program and will include a minimum of first year graduate courses. “The bulk of the specialty should consist of the most advanced courses available in the chosen area of research. These may include up to 12 hours of LOGM-899, Special Studies. Dissertation research hours, LOGM-999, including prospectus preparation, may not be included in the required technical method area.” Doctoral Council Policy Letter #1, Ph.D. Degree Requirements, https://www.afit.edu/ENS/doclib.cfm?dl=110.

5.1.2.2. MATHEMATICS REQUIREMENT. “The quantitative and analytical maturity expected of a Ph.D. student must be demonstrated. To achieve this quality goal, Ph.D. studies at AFIT are to include the study of mathematics (and/or statistics). In order to complete this area of study successfully, the student must complete with grades of B or better two courses (a minimum of 8 quarter-hours credit) offered by the AFIT Department of Mathematics and Statistics at the 6xx level or above.”
“Courses from DAGSI partner institutions, if approved, may be used to meet this requirement. The student shall petition the AFIT Department of Mathematics and Statistics, preferably in advance, to approve such DAGSI courses as being appropriate in content area and level.”


5.1.3. GENERAL REQUIREMENTS OF THE PH.D. PROGRAM IN LOGISTICS

5.1.3.1. LOGISTICS CORE COURSES. The Logistics Core coursework requirement is designed to provide broad exposure to the key areas of logistics at a level commensurate with Ph.D. study. The Ph.D. Core consists of the following courses:

- LOGM 601 - Principles and Methods of Research
- LOGM 612 – Maintenance and Sustainment
- LOGM 617 - Transportation Systems and Strategic Mobility
- LOGM 682 – Business Analytics II
- LOGM 768 - Advanced Topics in Logistics
- LOGM 770 - Advanced Inventory Theory
- OPER 561 – Discrete Event Simulation

Ph.D. students must satisfy the Ph.D. core requirements by explicitly completing the aforementioned courses, or by equivalent courses completed at other academic institutions. The Department will review external courses to determine their suitability for substitution in the core requirements.

5.1.3.2. TECHNICAL METHODS AREA. The technical methods and electives courses together foster interdisciplinary opportunities in areas such as operations research, statistics, and systems engineering. A program of study would be tailored to the student’s research thrust, and are established in consultation with the Advisor (see Section 4 of this guide). This becomes part of the student's official Ph.D. program of study, and is recorded in accordance with policy in Doctoral Council Policy Letter #5, Student Record located at https://www.afit.edu/ENS/doclib.cfm?dl=110.

5.1.3.3. SEMINARS AND RESEARCH METHODS. Ph.D. students are expected to enroll in either LOGM 675, Logistics Management Colloquium or OPER 601, Operations Research Seminar every quarter throughout the Ph.D. program of study. These courses provide a forum to acquaint students with current Air Force and DoD community research methods, faculty research interests, and lectures by distinguished visitors and prominent speakers.

5.1.3.4. RESEARCH ADVISOR AND COMMITTEE. For general guidance on selection of Pro-Tem and Research advisor, Ph.D. students are referred to the Doctoral Council Policy Letter #4, Pro-Tem Advisor and Research Advisor. For doctoral students in Logistics, the
Research Advisor and at least one other member of the student’s committee must be members of the full-time, permanent Logistics or Operations Research faculty.

New students report to the Head of the Operational Sciences Department. The Head, in consultation with the Ph.D. program director, will appoint a Pro-Tem advisor for the student. This selection will be made in light of considerations including: student research interests, faculty workload, and the general guidance given in the Doctoral Council’s Policy Letters. The duties of the Pro-Tem are specified in the Doctoral Council’s Policy Letters. Specifically, the Pro-Tem advisor will ensure that an initial education plan is drafted and approved by the Head of the Department of Operational Sciences and that the student is registered for classes in his/her first academic term. Moreover, the Pro-Tem advisor is to ensure that the new student meets and discusses research interests with each member of the Logistics faculty.

5.1.3.5. EXAMINATIONS AND DISSERTATION DEFENSE. The conduct of the Specialty and Prospectus examinations, as well as the dissertation defense are, respectively, outlined in the Doctoral Council Policy Letters, Specialty Examination, Prospectus Examination, and Evaluation and Defense of the Dissertation.

Dissertation defenses will be publicized. It is the student’s responsibility to ensure that this is accomplished. Students must go into the AFIT intranet page at https://cf.afit.edu/thesiscalendarentry/ to complete and submit the Thesis and Dissertation Defense Announcement Entry Form. Completion of this form results in the dissertation announcement being posted on the AFIT Graduate School’s intranet Thesis and Dissertation Defense Announcement calendar at https://cf.afit.edu/thesiscalendar. Students must inform the ENS Executive Manager that they have added their dissertation defense to the intranet calendar.

5.1.3.6. RESIDENCY REQUIREMENTS. The residency requirement for the Ph.D. program is three quarters of full-time study in residence during any contiguous four-quarter period [EN01 36-114, 1 June 2011].

5.1.3.7. DOCTORAL DISSERTATION. As with all doctoral programs, the AFIT resident Ph.D. program requires completion of a doctoral dissertation. The dissertation research consists of at least 48 quarter hours of supervised research and should result in a significant and original archival contribution to the literature of the field. The AFIT dissertation is also generally oriented toward a topic of relevance to the US Air Force.

5.1.3.8. TIMELINES. AFIT’s Doctoral Council provides policy guidance for the PhD program through its Policy Letters. These are found at https://www.afit.edu/ENS/doclib.cfm?dl=110.

Students should familiarize themselves with these documents. In these documents expected times when students must take their qualifying exams, prospectus defense, and enter into candidacy are delineated. The general guidelines that follow are taken from the Doctoral Policy Letters.
Qualifying Examinations

If a minor examination is required, it should be administered no later than the end of coursework and before the Specialty Examination.

The Specialty Examination shall normally be administered before the end of the 5th quarter in residence. It shall be administered by the student's Research Committee.

After the student has prepared a prospectus on the selected dissertation research project, the Research Committee will examine him or her on that prospectus. The Prospectus Examination should be started (and completed, normally) not later than 10 weeks after the end of formal coursework, but in no case will it begin later than the end of the 18th month after admission into full-time study in the Ph.D. program.

Admission to Candidacy

After completion of the approved course of study and all examinations (except the dissertation defense), and after committee approval of the research prospectus, the student should submit a request to the Dean through the research advisor, department head, and the academic standards committee of the school’s faculty council, requesting admission to candidacy for the Ph.D. degree. It is a degree requirement that students be admitted to candidacy at least one year prior to the award of the degree. Students who have not been admitted to candidacy by the end of the seventh quarter from the beginning of full-time study shall be considered to be exhibiting unsatisfactory progress.

Dissertation Research Registration

Effective with students entering the program in summer 1994, a minimum of 48 hours of research, supervised by a member of the faculty of the Graduate School of Engineering, are required for the doctoral degree. Accordingly, students entering Summer 1994 and thereafter should include in their plan of study at least 48 credits of research.

5.1.4. SPECIALTY AREAS OF LOGISTICS

A particular choice of technical methods and elective courses constitute an area of specialty. Typical areas of specialty, as defined by the Logistics faculty of the Department of Operational Sciences, include but are not limited to: (i) Reliability, (ii) Optimization, (iii) Applied Statistics, and (iv) System Architectures. Elective courses are selected to complement and integrate the student’s technical methods courses toward supporting their particular research problem.

5.1.4.1. RELIABILITY

LOGM 634 - Reliability, Maintainability, and Supportability

OPER 746 - Advanced Topics in Reliability
5.1.4.2. OPTIMIZATION

OPER 610 - Linear Programming
OPER 617 - Networks

5.1.4.3. APPLIED STATISTICS

OPER 685 - Applied Multivariate Analysis I
OPER 785 - Applied Multivariate Analysis II: Pattern Recognition

5.1.4.4. SYSTEM ARCHITECTURES

SENG 640 - Systems Architecture
SENG 740 - Advanced Topics in Systems Architecture

5.1.5. POINTS OF CONTACT:

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Academic and Program Matters:
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Applications and Personnel Matters:

Military personnel questions should be fielded with the Assignment Teams at HQ AFPC.

General Admission queries are handled by the Graduate Admissions Office, AFIT/ENER. An on-line application form, more information on the Logistics Ph.D. program admission criteria, and required admission documents are available at the Admission Office website at http://www.afit.edu/ADMISSIONS/doclib.cfm?dl=24, or by contacting an Admission Office counselor by phone at 1-800-211-5097 ext 3184 or by e-mail http://www.afit.edu/ADMISSIONS/facdir.cfm.
5.1 - Appendix A: PhD Assistantships

A.1 – What is a PhD Assistantship?

Beginning in academic year 2008-2009, the Department of Operational Sciences (AFIT/ENS) began advertising Ph.D. assistantships. These assistantships are funded by individual faculty research initiatives and thus the award of these assistantships are based on (1) student eligibility for the Ph.D. program, (2) availability of the research funding, (3) student interest and competency in the research area, and (4) acceptance of the student by faculty funding the assistantship. As with any assistantship, continuation of any awarded assistantship is based on both performance in the research and research initiative, funds availability, and academic progress.

An assistantship is a research employment arrangement between the student and the faculty and includes a stipend as well as tuition. The research employment will include research deliverables over and above the deliverables associated with coursework and doctoral dissertation progress. Students under an assistantship agreement work for the faculty funding the assistantship and are expected to maintain progress on research project tasks as well as in their doctoral program. Requirements for the Ph.D. while in an assistantship match the general Logistics Ph.D. program requirements.

A.2 - The Assistantship Application Process

Prospective students interested in an AFIT/ENS Ph.D. Assistantship need to first apply for the AFIT/ENS Ph.D. in the normal manner. The application package includes all transcripts, GRE scores, and recommendation letters. Once the application process is complete, the candidate’s record is examined by the Department of Operational Science for admittance into their Ph.D. program. This admittance determination is based on normal Ph.D. program requirements and is a necessary condition for the award of a Ph.D. Assistantship. If the applicant is admitted to the Ph.D. program in Logistics, the applicant’s record is then circulated among potential research faculty for their consideration to fund the Assistantship. Once an applicant is admitted and a faculty member has agreed to fund the Assistantship, then the applicant can be offered the Assistantship. Further application details are provided to the prospective Assistant at that time.

Acceptance of the Assistantship, and entry into the AFIT/ENS PhD in Logistics, provides the applicant potentially a part-time AD-21 position or contractor Research Assistantship position. As of August 2009, the pay for this position was up to $36000 per year to optionally include tuition and partial to full health benefit coverage. Typically, these positions will start at a pay level below the cap and provide merit-based increases during the period of the assistantships. Continuation of all Assistantships is based on research progress and research program funding; once granted, Assistantships are not guaranteed.
5.1 - Appendix B: Transfer of courses from a MS into the PhD Program

Transferring courses into the PhD program is not allowed. However, it is possible to waive up 12 hours of course requirements under the provisions that [1] the courses were not used to satisfy MS course requirements and [2] the total number of graduate course hours does not, as a result of the waiver, drop below 72 hours (Ref: Doctoral Policy Letter, Course Requirements, Revision Approved: 29 June 2007).
5.1 - Appendix C: Student Workload

Enrollment requirements for Ph.D. students will be administered according to Table C.1 below.

<table>
<thead>
<tr>
<th>Table C.1 Full Time Course Load Requirements</th>
<th>*Full Time (12 Qtr Hr) Course Load Required</th>
<th>Full Time (9 Qtr Hr) Course Load Required (RAs &amp; TAs Only)</th>
<th>**Modified Full Time (12 Qtr Hr) Course Load Required</th>
<th>No Specific Per/Quarter Course Enrollment Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign Military Officers.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students holding Research Assistantships (RA) or Teaching Assistantships (TA)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Other Ph.D. Degree-seeking Students Not Categorized Above</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

*The requirement can be waived in certain instances. For example, entering full-time Ph.D. students typically take two MATH courses and a LOGM course in their first quarter. Math courses are typically 4 credit hours and LOGM courses are typically 3 credit hours; hence an acceptable (subject to advisor) 11 hour quarter often results.

**Modified full time: If the academic deficiency is missing prerequisite course(s), the federal government-sponsored student may arrive 1-2 quarters early solely to take prerequisite UG or graduate courses. In this case, the student may rightly not be enrolled full time at AFIT prior to commencing his/her graduate program. However, if the academic deficiency is due to marginal undergraduate performance but with no missing prerequisites, and the department, with agency concurrence, has admitted for an extended program length to allow a slower pace for success, then the student may be enrolled for less than full time over an extended number of quarters. Quarterly extensions may be at the beginning and/or added to end of the program, pushing the graduation date out.
5.1 – Appendix D: Program Outcomes

Program Outcomes (POs)

POs are the desired achievements of the program as evidenced by the demonstrated abilities and accomplishments of the students upon graduation. Source: EN Doctoral Council Policy Letter #0 “The Doctor of Philosophy Degree” 12 March 2010 at: https://www.afit.edu/ENS/doclib.cfm?dl=110.

1. The graduates will be able to understand and evaluate critically the literature of the field.
2. The graduates will be able to apply appropriate principles and procedures to the recognition, evaluation, interpretation, and understanding of issues and problems at the frontiers of knowledge.
3. The graduates will have acquired the knowledge, skills, ethics, and independence of thought and action expected of a scholar.
4. The graduates will have extended and effectively communicated knowledge in his or her field.

Methods used to assess Program Outcomes (POs)

Doctoral program assessment measures have been drafted by the Graduate School Doctoral Council, but have not yet been approved. Methods of assessment will be posted to this Program Guide when approved and provided by the Doctoral Council.
5.2. DOCTOR OF PHILOSOPHY IN OPERATIONS RESEARCH

5.2.1. THE DOCTOR OF PHILOSOPHY DEGREE
The Doctor of Philosophy (Ph.D.) degree entails completion of rigorous coursework requirements that prepare the student for advanced research and analysis in a chosen field of study. The doctoral degree is generally characterized as a research degree with substantial emphasis placed on the completion of the dissertation research.

Close interaction between the student and his/her research advisory committee plays a pivotal role in the successful completion of the Ph.D. program. Equally important is the discipline and dedication of the student, as independent study is a critical element for timely program completion.

5.2.1.1. AIR FORCE INSTITUTE OF TECHNOLOGY PH.D. IN OPERATIONS RESEARCH. Doctoral study in Operations Research (OR) provides a path for Air Force and Department of Defense (DoD) personnel (service members as well as civilians) to pursue research topics in advanced Operations Research. Typically, Air Force officers selected for Ph.D. programs carry a specialty code of 61A, and civilian employees an occupation series of 1500. In addition, DoD contractors and some civilians may also pursue doctoral study in Operations Research at the Air Force Institute of Technology. Admission requirements for all students are the same. Non-Air Force quota DoD students and other students do not affect the Air Force educational quotas outlined in Section 5.2.1.2. Limited Ph.D. Assistantships are available for qualified civilians. See Appendix A for details on Assistantships.

5.2.1.2. AIR FORCE QUOTA PERSONNEL. Air Force Ph.D. educational quotas such as Operations Research (Education Code 0YEY) and Operational Analysis (Education Code 0YSY) have been established to satisfy three general categories of Air Force needs: (1) At-large quotas referred to as “Air Force sponsored,” (2) Pipeline instructor quotas with a commitment to join the AFIT faculty upon completion of the degree, and (3) U.S. Air Force Academy instructor quotas. This Ph.D. program supports at minimum Air Force education codes 0YEY, 0YSY, 6EDY (Mathematics of Research/Biometrics/Biostatistics), 6EMY (Mathematics of Resource/Operation Research) and 6EOY (Mathematics of Research/Weapons Systems Evaluation).

Category (1) quotas provide analysts for any Ph.D. assignments in the Air Force while the others are specifically geared toward faculty assignments. Applicants interested in either category (1) or category (2) should indicate their preference when they apply. Category (3) quotas are controlled by the U.S. Air Force Academy (USAFA), which sends selected faculty for a doctoral degree upon completion of an initial teaching assignment.

5.2.1.3 ELIGIBILITY AND ADMISSION REQUIREMENTS FOR THE PH.D. PROGRAM. To be considered for Ph.D. admission, an applicant must first establish eligibility by submitting an application for review of eligibility, including transcripts, Graduate Record Examination (GRE) scores, and letters of recommendation to the AFIT Admissions Office.
(AFIT/ENER). Exceptions are made only for students currently enrolled in the master's programs in residence at AFIT who seek extension directly into the Ph.D. program. In such cases, the student submits a Change of Enrollment Status Form, available from the Registrar’s Office, which the Admissions Office forwards to the Operations Research faculty who performs the eligibility screening. In addition to the requirements listed above, all applicants should submit a letter to the Ph.D. Program Director summarizing their background, potential research interests and reasons for pursuing doctoral studies.

In accordance with the AFIT Doctoral Council Policy Letters, a student possessing a master's degree who seeks to enter a doctoral program must meet the following minimum requirements:

1. A quality bachelor’s degree with grades averaging at least 3.0 on a 4.0 scale
2. A quality master’s degree with grades averaging at least 3.5 on a 4.0 scale
3. Successful completion of a master’s thesis is very desirable
4. GRE scores of at least 156 (verbal) and 151 (quantitative) on the Education Testing Service (ETS) 2012 GRE Concordance Table (which is based upon performance of all examinees who tested between 1 Aug 2011 and 30 April 2012; or 550 (verbal) and 650 (quantitative) for GRE tests taken/scored under the old scale used by ETS prior to August 2011.

Eligibility also requires background, education, and experience compatible with advanced graduate study in Operations Research. (Typically, students entering the Ph.D. program will possess a M.S. degree in operations research, mathematics, engineering, statistics, or quantitative analysis.) All application packages are referred to the Operations Research faculty of the Department of Operational Sciences for review and recommendation. Waivers to the above criteria may be granted on a case-by-case basis.

The student’s prior coursework should enable him/her to complete the Operations Research core courses listed below, as well as the mathematics requirement described in Section 5.2.3.4. (Prospective students should contact the Department for an assessment if needed.) If a prospective student does not meet these requirements, remedial coursework (beyond the Ph.D. requirements) will be necessary. See Appendix B for information regarding the transfer of courses from a MS to the Ph.D. program. The prerequisites for the Operations Research core courses are given below:

<table>
<thead>
<tr>
<th>Core Course</th>
<th>Prerequisite Course(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPER 612 Nonlinear Programming</td>
<td>OPER 610 or Instructor Approval</td>
</tr>
<tr>
<td>OPER 641 Stochastic Modeling and Analysis II or OPER 647 Queueing System Analysis</td>
<td>OPER 540 or Instructor Approval</td>
</tr>
<tr>
<td>OPER 661 Statistical Aspects of Simulation: Output Analysis</td>
<td>OPER 561 or Instructor Approval</td>
</tr>
<tr>
<td>OPER 683 Response Surface Methodology</td>
<td>OPER 679 or STAT 696 and OPER 688 or Instructor Approval</td>
</tr>
</tbody>
</table>
A complete listing of course descriptions for Operations Research may be found at https://www.afit.edu/ENER/doclib.cfm?dl=31 in the course description section of the current Graduate Catalog.

Each year, the AFIT Admissions Office forwards records of all applicants for the Ph.D. program to the Department of Operational Sciences for review. The Department considers this pool along with potential, in-resident master’s degree candidates at AFIT. Assessing the research potential of each candidate is an integral part of the evaluation process. The Department returns a prioritized list of active duty Air Force officer candidates to the Admissions Officer, who then forwards the list to the Air Force Personnel Center (AFPC). Final assignment decisions are made by AFPC. All other applications from U.S. citizens may be considered at any time. Once eligibility has been established, the applicant is notified by letter. Likewise, AFPC is informed of the eligibility and, if applicable, the volunteer status of the candidate.

5.2.1.4 BACHELOR'S DEGREE ENTRY INTO THE PH.D. PROGRAM. This program allows exceptionally well-qualified students to pursue a Ph.D. directly from Bachelor degree programs. Participants in the program need to fulfill all the requirements of the Graduate Operations Research M.S. program and those prescribed in this guide. These students are governed by the Doctoral Committee Policy Letter, Bachelor Entry to Ph.D. Program, at: https://www.afit.edu/ENS/doclib.cfm?dl=110.

This program requires significant advance planning for success. A Pro-Tem advisor will be appointed by the Head of the Department of Operational Sciences in consultation with the Ph.D. program director as far in advance of the beginning of the student’s program as is reasonable. The Pro-Tem advisor fills a wider role for this type of student as compared to an entering student with an appropriate M.S. degree. As prescribed in the policy letter, the Pro-Tem advisor is expected to be the M.S. thesis advisor and, subsequently, the Ph.D. research advisor as well. Hence, these students will be required to provide detailed information on their potential areas of research interest prior to the assignment of a Pro-Tem advisor.

5.2.2. AFIT PH.D. COURSEWORK REQUIREMENTS
The Department of Operational Sciences administers AFIT’s Ph.D. program in Operations Research. Candidates selected to fill 0YSY billets are expected to take Operational Analysis sequence (see paragraph 4.5). Quarterly workload requirements are discussed in Appendix C. Requirements for the Ph.D. degree typically include 41 (for a well prepared student not needing to take the Core courses) to 53 quarter-hours of coursework beyond the master's degree and a period of full-time research leading to successful completion of the doctoral dissertation. In addition to the Core courses, the three required coursework areas are: (i) specialty area requirements (24 hrs), (ii) minor area requirements (9 hrs), and (iii) mathematics requirements (8 hrs). Each of these requirements is described in the subsections that follow.

5.2.2.1 SPECIALTY AREA. “The minimum 24 hours of specialty area courses may consist of courses from more than one department as long as these courses form an integrated program designed to make the student an expert in the chosen area of research. In some cases this may require more than 24 hours. These specialty courses normally build on the individual student's
MS program and will include a minimum of first year graduate courses. The bulk of the specialty should consist of the most advanced courses available in the chosen area of research. These may include up to 12 hours of OPER-899, Special Studies. Dissertation research hours, OPER-999, including prospectus preparation, may not be included in the required 24 hours of specialty area.” Doctoral Committee Policy Letter #1, Ph.D. Degree Requirements: https://www.afit.edu/ENS/doclib.cfm?dl=110.

5.2.2.2 MINOR AREA. The Department of Operational Sciences requires that PhD students complete a 9 credit hour minor sequence. This sequence is intended to broaden the student’s exposure to graduate coursework. Successful completion of the minor area of study may also include completion of a minor examination requirement. A minor exam is required for OR PhD students if their overall GPA is less than 3.5 or their average GPA for the courses in their minor sequence is less than 3.7. Operations Research Ph.D. students have considerable flexibility when establishing a minor area of study. A student may choose an area within Operations Research other than his or her specialty area (see Section 4); however, the minor may also originate in another department (provided that the minor is acceptable to the other Department and that it is supported by that Department). Some examples of minor areas may include applied statistics, mathematics, and computer science.

5.2.2.3 MATHEMATICS REQUIREMENT. “The quantitative and analytical maturity expected of a Ph.D. student must be demonstrated. To achieve this quality goal, Ph.D. studies at AFIT are to include the study of mathematics (and/or statistics). In order to complete this area of study successfully, the student must complete with grades of B or better two courses (a minimum of 8 quarter-hours credit) offered by the AFIT Department of Mathematics and Statistics at the 6xx level or above.”

“Courses from DAGSI partner institutions, if approved, may be used to meet this requirement. The student shall petition the AFIT Department of Mathematics and Statistics, preferably in advance, to approve such DAGSI courses as being appropriate in content area and level.” Doctoral Committee Policy Letter, Mathematics Requirement: https://www.afit.edu/ENS/doclib.cfm?dl=110.

Specific mathematics requirements for Ph.D. students in Operations Research are outlined in Section 5.2.3.4.

5.2.3. GENERAL REQUIREMENTS: PH.D. PROGRAM IN OPERATIONS RESEARCH

5.2.3.1 OPERATIONS RESEARCH CORE COURSES. The Operations Research Core coursework requirement is designed to provide broad exposure to the key areas of operations research at a level commensurate with Ph.D. study. The Ph.D. Core consists of the following courses:

- OPER 612 - Nonlinear Programming
- OPER 641 - Stochastic Modeling and Analysis II
- OPER 661 - Statistical Aspects of Simulation: Output Analysis
- OPER 683 - Response Surface Methodology
Ph.D. students must satisfy the Ph.D. core requirements by explicitly completing the aforementioned courses, or by equivalent courses completed at other academic institutions. The Department will review external courses to determine their suitability for substitution in the core requirements.

5.2.3.2 SPECIALTY AREA. The specialty area is a specific concentration of Operations Research focused on the dissertation research. A specialty sequence may consist of courses from the Ph.D. core as well as elective courses to provide depth and focus for the research. The courses that constitute the specialty area are established in consultation with the Advisor (see Section 4 of this guide). This becomes part of the student's official Ph.D. program of study, and is recorded in accordance with policy in Doctoral Council Policy Letter, Specialty Sequence: https://www.afit.edu/ENS/doclib.cfm?dl=110.

5.2.3.3 MINOR AREA. The minor area is a related area of study designed to support and/or complement the specialty area. The courses that constitute the minor area are established in consultation with the Advisor and other appropriate faculty members if the minor originates in a program other than Operations Research.

5.2.3.4. OPERATIONS RESEARCH MATHEMATICS REQUIREMENT. In accordance with the AFIT Ph.D. mathematics requirement (see Section 2.3), Ph.D. students in Operations Research are required to complete MATH 600 and MATH 621. A waiver request to change these requirements requires advisor and ENS Ph.D. program director approval.

5.2.3.5. SEMINARS AND RESEARCH METHODS. Ph.D. students are expected to enroll in the operations research seminar (OPER 601) every quarter throughout the Ph.D. program of study. These seminars provide a forum to acquaint students with current operations research practice in the Air Force and DoD analysis communities, state-of-the-art research within the operations research discipline, faculty research interests, lectures by distinguished visitors and prominent speakers, and research methods.

5.2.3.6. RESEARCH ADVISOR AND COMMITTEE. For general guidance on selection of Pro-Tem and Research advisor, Ph.D. students are referred to the Doctoral Committee Policy Letter, Pro-Tem Advisor and Research Advisor. For doctoral students in Operations Research, the Research Advisor and at least one other member of the student’s committee must be members of the full-time, permanent Operations Research faculty.

New students report to the Head of the Operational Sciences Department. The Head, in consultation with the Ph.D. program director, will appoint a Pro-Tem advisor for the student. This selection will be made in light of considerations including: student research interests, faculty workload, and the general guidance given in the Doctoral Committee Policy Letters. The duties of the Pro-Tem are specified in the Doctoral Committee Policy Letters. Specifically, the Pro-Tem advisor will ensure that an initial education plan is drafted and approved by the Head of the Department of Operational Sciences and that the student is registered for classes in his/her first academic term. Moreover, the Pro-Tem advisor is to ensure that the new student meets and discusses research interests with each member of the Operations Research faculty.
5.2.3.7. EXAMINATIONS AND DISSERTATION DEFENSE. The conduct of the Specialty and Prospectus examinations, as well as the dissertation defense, are respectively outlined in the Doctoral Committee Policy Letters, Specialty Examination, Prospectus Examination, and Evaluation and Defense of the Dissertation.

Dissertation defenses will be publicized. It is the student’s responsibility to ensure that this is accomplished. Students must go into the AFIT intranet page at https://cf.afit.edu/thesiscalendarentry/ (requires CAC access) to complete and submit the Thesis and Dissertation Defense Announcement Entry Form. Completion of this form results in the dissertation announcement being posted on the AFIT Graduate School’s intranet Thesis and Dissertation Defense Announcement calendar at https://cf.afit.edu/thesescalendar/. Students must inform the ENS Graduate Advisor that they have added their dissertation defense to the intranet calendar.

5.2.3.8. RESIDENCY REQUIREMENTS. The residency requirement for the Ph.D. program is three quarters of full-time study enrollment during any contiguous four-quarter period [ENOI 36-114, 1 June 2011].

5.2.3.9. DOCTORAL DISSERTATION. As with all doctoral programs, the AFIT resident Ph.D. program requires completion of a doctoral dissertation. The dissertation research consists of at least 48 quarter hours of supervised research (OPER 999) and should result in a significant and original archival contribution to the literature of the field. The AFIT dissertation is also generally oriented toward a topic of relevance to the US Air Force. A complete listing of Operations Research Ph.D. degrees granted in available at https://www.afit.edu/ENS/awards/degrees.cfm.

5.2.3.10. TIMELINES. AFIT's Doctoral Committee provides policy guidance for the PhD program through its Policy Letters. These are found at https://www.afit.edu/ENS/doclib.cfm?dl=110.

Students should familiarize themselves with these documents. In these documents expected times when students must take their qualifying exams, prospectus defense, and enter into candidacy are delineated. The general guidelines that follow are taken from the Doctoral Policy Letters.

Qualifying Examinations

If a minor examination is required, it should be administered no later than the end of coursework and before the Specialty Examination.

The Specialty Examination shall normally be administered before the end of the 5th quarter of full time study in residence. It shall be administered by the student's Research Committee and involves a written response to examination questions and an oral defense of those responses. The oral defense can be moved into the prospectus defense with advisor approval.

After the student has prepared a prospectus on the selected dissertation research project, the Research Committee will examine him or her on that prospectus. The Prospectus Examination should be started (and completed, normally) not later than 10 weeks after the end of formal
course work, but in no case will it begin later than the end of the 18th month after admission into full-time study in the Ph.D. program.

Admission to Candidacy

After completion of the approved course of study and all examinations (except the dissertation defense), and after committee approval of the research prospectus, the student should submit a request to the Dean through the research advisor, department head, and the academic standards committee of the school’s faculty council, requesting admission to candidacy for the Ph.D. degree. It is a degree requirement that students be admitted to candidacy at least one year prior to the award of the degree. Students who have not been admitted to candidacy by the end of the seventh quarter from the beginning of full-time study shall be considered to be exhibiting unsatisfactory progress.

Dissertation Research Registration

Effective with students entering the program in summer 1994, a minimum of 48 hours of research, supervised by a member of the faculty of the Graduate School of Engineering, are required for the doctoral degree. Accordingly, students entering Summer 1994 and thereafter should include in their plan of study at least 48 credits of research.

5.2.4. SPECIALTY AREAS OF OPERATIONS RESEARCH

The typical areas of specialty, as defined by the Operations Research faculty of the Department of Operational Sciences, are as follows: (i) Optimization, (ii) Stochastic Operations Research, (iii) Simulation, (iv) Applied Statistics, and (v) Decision Analysis. The courses in each specialty and minor as typically defined is described in the subsections that follow.

5.2.4.1. OPTIMIZATION SPECIALTY AREA.

OPER 612 - Nonlinear Programming
OPER 613 - Integer Programming
OPER 614 - Dynamic Programming
OPER 615 - Large Scale Systems Optimization
OPER 617 - Networks
OPER 621 - Multicriteria Optimization
OPER 623 - Heuristic Search Methods
OPER 626 - Scheduling Theory
OPER 710 - Advanced Linear Programming and Extensions
OPER 712 - Advanced Math Programming
OPER 713 - Advanced Integer Programming
OPER 899 - Independent Study

Notes: (i) OPER 610 may not be used to satisfy any Ph.D. coursework requirements for the specialty area.
5.2.4.2. STOCHASTIC OPERATIONS RESEARCH.

OPER 613 - Integer Programming
OPER 614 - Dynamic Programming
OPER 617 - Networks
OPER 626 - Scheduling Theory
OPER 641 - Stochastic Modeling and Analysis II
OPER 647 - Queueing System Analysis
OPER 661 - Statistical Aspects of Simulation: Output Analysis
OPER 684 - Quantitative Forecasting Techniques
OPER 746 - Advanced Topics in Reliability
OPER 899 - Independent Study
EENG 765 - Stochastic Estimation and Control I (Requires EENG 510 and STAT 586 or STAT 601)
MATH 601 - Complex Analysis
MATH 607 - Calculus of Variations
MATH 611 - Introduction to Partial Differential Equations
MATH 674 - Intro to Numerical Analysis
MATH 676 - Numerical Analysis for Partial Differential Equations
STAT 601 - Theory of Probability
STAT 602 - Mathematical Statistics
STAT 687 - Mathematics of Reliability Theory I

Notes: (i) OPER 540 may not be used to satisfy any Ph.D. coursework requirements for the specialty area.

5.2.4.3. SIMULATION.

OPER 614 - Dynamic Programming
OPER 626 - Scheduling Theory
OPER 641 - Stochastic Modeling and Analysis II
OPER 647 - Queueing System Analysis
OPER 661 - Statistical Aspects of Simulation: Output Analysis
OPER 685 - Applied Multivariate Analysis I
OPER 899 - Independent Study
STAT 601 - Theory of Probability
STAT 602 - Mathematical Statistics

5.2.4.4. APPLIED STATISTICS.

OPER 647 - Queueing System Analysis
OPER 661 - Statistical Aspects of Simulation: Output Analysis
OPER 679 - Empirical Modeling
OPER 683 - Response Surface Methodology
OPER 685 - Applied Multivariate Analysis I
OPER 688 - Operational Experimentation
OPER 785 - Applied Multivariate Analysis II: Pattern Recognition
OPER 786 - Multivariate Analysis III: Advanced Topics

5.2.4.5. DECISION ANALYSIS (THIS SPECIALTY AREA IS UNDER CONSTRUCTION)

OPER 621 - Multicriteria Optimization
OPER 642 - Decision Analysis under Uncertainty and Risk
OPER 671 - Combat Modeling
OPER 674 - Joint Mobility Modeling
OPER 676 - Information Operations Research
OPER 685 - Applied Multivariate Analysis I
OPER 743 - Decision Analysis Practice
OPER 785 - Applied Multivariate Analysis II: Pattern Recognition
OPER 899 - Independent Study

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http://www.afit.edu/directory/faclook.cfm?id=107

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Email: Raymond.Hill@afit.edu
https://www.afit.edu/BIOS/bio.cfm?facID=84

Applications and Personnel Matters:

Military personnel questions should be fielded with the Assignment Teams at AFPC.

General Admission queries are handled by the Graduate Admissions Office, AFIT/ENER. An on-line application form, more information on the Operations Research Ph.D. program admission criteria, and required documents are available at the Admission Office website at http://www.afit.edu/ADMISSIONS/doclib.cfm?dl=24, or by contacting an Admission Office counselor by phone at 1-800-211-5097 ext 3184 or by e-mail at http://www.afit.edu/ADMISSIONS/facdir.cfm.
5.2 – Appendix A: PhD Assistantships

A.1 – What is a PhD Assistantship?

Beginning in academic year 2008-2009, the Department of Operational Sciences (AFIT/ENS) began advertising Ph.D. assistantships. These assistantships are funded by individual faculty research initiatives and thus the award of these assistantships are based on (1) student eligibility for the Ph.D. program, (2) availability of the research funding, (3) student interest and competency in the research area, and (4) acceptance of the student by faculty funding the assistantship. As with any assistantship, continuation of any awarded assistantship is based on both performance in the research and research initiative, funds availability, and academic progress.

An assistantship is a research employment arrangement between the student and the faculty and includes a stipend as well as tuition. The research employment will include research deliverables over and above the deliverables associated with coursework and doctoral dissertation progress. Students under an assistantship agreement work for the faculty funding the assistantship and are expected to maintain progress on research project tasks as well as in their doctoral program. Requirements for the Ph.D. while in an assistantship match the general Operations Research Ph.D. program requirements.

A.2 – The Assistantship Application Process

Prospective students interested in an AFIT/ENS Ph.D. Assistantship need to first apply for the AFIT/ENS Ph.D. in the normal manner. The application package includes all transcripts, GRE scores, and recommendation letters. Once the application process is complete, the candidate’s record is examined by the Department of Operational Science for admittance into their Ph.D. program. This admittance determination is based on normal Ph.D. program requirements and is a necessary condition for the award of a Ph.D. Assistantship. If the applicant is admitted to the Ph.D. program in Operations Research, the applicant’s record is then circulated among potential research faculty for their consideration to fund the Assistantship. Once an applicant is admitted and a faculty member has agreed to fund the Assistantship, then the applicant can be offered the Assistantship. Further application details are provided to the prospective Assistant at that time.

Acceptance of the Assistantship, and entry into the AFIT/ENS PhD in Operations Research, provides the applicant potentially a part-time AD-21 position or contractor Research Assistantship position. As of August 2009, the pay for this position was up to $36000 per year to optionally include tuition and partial to full health benefit coverage. Typically, these positions will start at a pay level below the cap and provide merit-based increases during the period of the assistantships. Continuation of all Assistantships is based on research progress and research program funding; once granted, Assistantships are not guaranteed.
5-2 - Appendix B: Transfer of courses from a MS into the PhD Program

Transferring courses into the PhD program is not allowed. However, it is possible to waive up 12 hours of course requirements under the provisions that [1] the courses were not used to satisfy MS course requirements and [2] the total number of graduate course and thesis hours do not, as a result of the waiver, drop below 72 hours (Ref: Doctoral Committee Policy Letter, Waivers from Required Coursework).
5.1 - Appendix C: Student Workload

Enrollment requirements for Ph.D. students will be administered according to Table C.1 below.

<table>
<thead>
<tr>
<th>Table C.1 Full Time Course Load Requirements</th>
<th>*Full Time (12 Qtr Hr) Course Load Required</th>
<th>Full Time (9 Qtr Hr) Course Load Required (RAs &amp; TAs Only)</th>
<th>** Modified Full Time (12 Qtr Hr) Course Load Required</th>
<th>No Specific Per/Quarter Course Enrollment Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Type</td>
<td>*</td>
<td>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreign Military Officers.</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students holding Research Assistantships (RA) or Teaching Assistantships (TA)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Other Ph.D. Degree-seeking Students Not Categorized Above</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The requirement can be waived in certain instances. For example, entering full-time Ph.D. students typically take two MATH courses and an OPER course in their first quarter. Math courses are typically 4 credit hours and OPER courses are typically 3 credit hours; hence an acceptable (subject to advisor) 11 hour quarter often results.

**Modified full time: If the academic deficiency is missing prerequisite course(s), the federal government-sponsored student may arrive 1-2 quarters early solely to take prerequisite undergraduate or graduate courses. In this case, the student may rightly not be enrolled full time at AFIT prior to commencing his/her graduate program. However, if the academic deficiency is due to marginal undergraduate performance but with no missing prerequisites, and the department, with agency concurrence, has admitted for an extended program length to allow a slower pace for success, then the student may be enrolled for less than full time over an extended number of quarters. Quarterly extensions may be at the beginning and/or added to end of the program, pushing the graduation date out.
5.2 - Appendix D. Program Outcomes

Program Outcomes (POs)

POs are the desired achievements of the program as evidenced by the demonstrated abilities and accomplishments of the students upon graduation. Source: EN Doctoral Committee Policy Letter, Program Outcomes.

1. The graduates will be able to understand and evaluate critically the literature of the field.
2. The graduates will be able to apply appropriate principles and procedures to the recognition, evaluation, interpretation, and understanding of issues and problems at the frontiers of knowledge.
3. The graduates will have acquired the knowledge, skills, ethics, and independence of thought and action expected of a scholar.
4. The graduates will have extended and effectively communicated knowledge in his or her field.

Methods used to assess Program Outcomes (POs)

Doctoral program assessment measures have been drafted by the Graduate School Doctoral Council, but have not yet been approved. Methods of assessment will be posted to this Program Guide when approved and provided by the Doctoral Council.
CHAPTER 6: GRADUATE CERTIFICATE PROGRAMS

6.1 GRADUATE CERTIFICATE IN SUPPLY CHAIN MANAGEMENT

6.1.1 STATEMENT OF PURPOSE

The purpose of the Graduate Certificate in Supply Chain Management is to provide the students with graduate level education in the fundamentals of Supply Chain Management (SCM), with particular emphasis on Department of Defense (DoD) and Air Force specific applications. Statistical data analysis and basic quantitative modeling, to include linear programming, simulation analysis, and heuristics, are included. The objectives of this program are to educate Air Force logistics professionals in the above topics and to enable them to apply state of the art analytical and problem solving techniques to Air Force and DoD specific supply chain management problems.

6.1.2 ADMISSION REQUIREMENTS

DEGREE REQUIRED: Bachelor’s Degree or equivalent
MATHEMATICS REQUIRED: College Algebra
TEST REQUIRED: None
GPA REQUIRED: Overall 3.00 (on a 4.00 scale)

Waivers to the above criteria may be granted on a case by case basis. Therefore, individuals whose academic credentials fall below any of the above criteria are encouraged to apply.

6.1.3 DESCRIPTION OF THE CURRICULUM

The curriculum consists of five graduate level courses for a total of 17 graduate credits. In addition, there is a Business Math Review course that is a non-credit course. This math review class is to be taken prior to the student enrolling in following courses, and is a self-paced, web based course. No additional electives or research hours are required for the certificate. Typically, students will take one course per quarter depending on which quarter the classes are offered. The courses will be offered via distance learning. The courses are listed below. The Supply Chain Certificate program includes courses that may be applied to the Department of Operational Sciences logistics master’s degree programs, depending upon the specific course and program.
Certificate Completion Requirements

Successful completion of the Certificate Program requires a cumulative GPA on all course work of a 3.0 (based on a 4.0 scale). Cumulative time to completion is normally 5 quarters. There are no exit examinations required, and no final project. However, there are numerous projects and assignments required in the various courses that give an opportunity for the student to apply their knowledge to broad problems.

Credit Hours
MATH 001 Algebra Review (must be completed prior to STAT 583) 0

Graduate Courses
LOGM 568 Introduction to Supply Chain Management 3
LOGM 565 Strategic Sourcing 4
LOGM 569 Maintenance and Production Management 4
OPER 505 Business Analytics I 4
STAT 583 Introduction to Probability and Statistics 4

===
19 Total Credit Hours

6.1.4. POs: GRADUATE CERTIFICATE IN SUPPLY CHAIN MANAGEMENT

Our Program Outcomes (student knowledge/skills/abilities) produce graduate certificate conferees who exhibit:

1. The acquisition of a broad understanding of the principles and concepts of supply chain management and statistical concepts.

2. The ability to apply analytical techniques to SCM problems in the DoD environment.

3. Improved problem solving ability, critical thinking skills, and the ability to communicate.
6.2 GRADUATE CERTIFICATE IN TEST AND EVALUATION

6.2.1 STATEMENT OF PURPOSE

The AFIT Test and Evaluation Certificate Program (TECP) provides students a fundamental understanding in the statistical concepts required for supporting analysis in the Test and Evaluation (T&E) Community. Particular emphasis is given to incorporating past, present, and future DoD T&E examples from all aspects of test (developmental, operational, etc.) into the curriculum to tailor the applications of the methodology and approaches within each course. Current T&E focus in design of experiments (DOE) and reliability, maintainability, and availability (RM&A) analysis are addressed in required courses to complete the T&E Certificate Program. TECP targets individuals within the acquisition or analysis career fields working within research, developmental, or operational test stationed at engineering centers, test ranges, test centers, program offices or headquarters.

The T&E Certificate Program is designed to support both in-residence and part-time students. Select students participate in the TECP via distance learning. TECP students will take classes each quarter until completing the full certificate requirements. Initially, student enrollment is expected to be approximately 20-25 students per cohort. Course delivery is via asynchronous video with weekly synchronous classes to be held throughout the quarter.

The TECP also provides an avenue for personnel interested in completing an AFIT in-residence Master’s Degree in Operations Research. The possibility exists of full-time students attending AFIT for a shortened period to complete the Operations Research Master’s Degree, once completing the certificate program. The TECP provides an entry point into this program and supports the Applied Statistics track within this program of study. The first three courses in the certificate program would most likely apply to an AFIT Master’s program as well as other civilian universities near the student’s home station.

The TECP can be completed by full-time, in-residence students. Such students do not complete a capstone project or OPER 689 and may be able to substitute classes, actions approved on a case-by-case basis by the TECP Program Manager.

6.2.2 ADMISSION REQUIREMENTS

In order to be considered for admission to TECP, candidates must meet the AFIT Graduate School of Engineering and Management requirements for admissions. These are a completed bachelor’s degree in an appropriate engineering or scientific discipline (mathematics, physical science, engineering or computer sciences are highly desirable) and a minimum grade point average of 3.00. Additionally, successful completion of undergraduate calculus I and II is required. Waivers to the stated requirements may be granted on an individual basis as approved by the Department of Operational Sciences, through the TECP Program Manager.
6.2.3 DESCRIPTION OF THE CURRICULUM

TECP is a graduate level program focused on the application of statistical-based operational analysis techniques and methodology as applied to the T&E Community. The program provides an understanding of analysis tools dedicated to supporting the evaluation of test data, test design, and test execution. TECP is offered via distance learning for select students sponsored by SAF/AQ and in-residence students with all courses offered on the current AFIT quarter schedule, with STAT 583/STAT 587 being prerequisite to the other program courses. The expected completion time of the Certificate Program is 15-18 months of study.

The program of study for this certificate is divided into 3 areas: probability and statistics prerequisite course, T&E methodology courses, and a capstone project course. The T&E methodology courses include Empirical Modeling, Operational Experimentation with DOE applications, and RM&A. DL students can complete a capstone as an independent project encompassing the concepts of experimental design for systems research, design, engineering and test. This project is completed under the guidance of an AFIT faculty-mentor (or appropriate on-site designee) and results in a final graduate report. Most DL students complete the OPER 689 course in lieu of the capstone.

Certificate Completion Requirements

Students must attain a grade point average of at least 3.00 for all graded courses comprising the certificate.

### Graduate Courses (DL Students)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 583</td>
<td>Introduction to Probability and Statistics</td>
<td>4</td>
</tr>
<tr>
<td>OPER 679</td>
<td>Empirical Modeling</td>
<td>3</td>
</tr>
<tr>
<td>OPER 688</td>
<td>Operational Experimentation</td>
<td>3</td>
</tr>
<tr>
<td>LOGM 634</td>
<td>Reliability, Maintainability and Supportability</td>
<td>4</td>
</tr>
<tr>
<td>OPER 791</td>
<td>Research Project for Operational Sciences</td>
<td>3 OR</td>
</tr>
<tr>
<td>OPER 689</td>
<td>Advanced Statistical Methods for Test</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Total Credit Hours</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

### Graduate Courses (In-residence students)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 587</td>
<td>Introduction to Probability and Statistics</td>
<td>4</td>
</tr>
<tr>
<td>OPER 679</td>
<td>Empirical Modeling</td>
<td>3</td>
</tr>
<tr>
<td>OPER 688</td>
<td>Operational Experimentation</td>
<td>3</td>
</tr>
<tr>
<td>LOGM 634</td>
<td>Reliability, Maintainability and Supportability</td>
<td>4</td>
</tr>
<tr>
<td>OPER 683</td>
<td>Response Surface Methods</td>
<td>3 OR</td>
</tr>
<tr>
<td>OPER 685</td>
<td>Applied Multivariate Methods I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Total Credit Hours</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>
6.2.4. POs: GRADUATE CERTIFICATE IN TEST AND EVALUATION

Our program outcomes (student knowledge/skills/abilities) produce graduate certificate conferees who exhibit:

1. Improve problem solving ability, critical thinking skills, and test planning skills.

2. The ability to design experiments and conduct reliability, maintainability, and availability analysis in response to the operational needs of the Air Force and Department of Defense.

3. Improve problem solving ability, critical thinking skills, and test planning skills.
6.3 GRADUATE CERTIFICATE IN COST CAPABILITY ANALYSIS

6.3.1 STATEMENT OF PURPOSE

The AFIT Cost Capability Analysis Certificate Program (CCACP) provides students with a thorough understanding of Decision Analysis and its ability to facilitate more structured and informed decision-making in both military and industrial applications. Topics include the formulation of decision problems, identification of objectives and their level of achievement, specific multiobjective analysis techniques, risk assessment, and facilitation skills for working with decision makers and technical experts.

6.3.2 ADMISSION REQUIREMENTS

In order to be considered for admission to the CCACP, candidates must meet the AFIT Graduate School of Engineering and Management requirements for admissions. These requirements include a completed bachelor’s degree in an appropriate engineering or scientific discipline (mathematics, physical science, engineering, or computer science are highly desirable) and a minimum grade point average of 3.00. Moreover, successful completion of undergraduate courses in calculus I, calculus II, and probability is required. Waivers to the stated requirements may be granted on an individual basis as approved by the Department of Operational Sciences, through the CCACP Program Manager.

6.3.3 DESCRIPTION OF THE CURRICULUM

The CCACP is a graduate level program centered on the principles of decision analysis, the impact of risk assessment in decision making, and the role of operational cost analysis. The curriculum consists of four graduate level courses for a total of 13 graduate credits. The course sequence provides both a theoretical foundation of analysis techniques and insight concerning the interpersonal skills necessary for effective application of such techniques to real world decisions. The CCACP is designed to support part-time students. All students are expected to participate in the CCACP via one in-residence AFIT course for at least four quarters until completing the full certificate requirements. The courses are listed below.

Certificate Completion Requirements

Successful completion of the CCACP requires a cumulative GPA on all course work of a 3.0 (based on a 4.0 scale). Cumulative time to completion is normally 5 quarters. All required courses must be completed within a four year time period. There are no exit examinations required, and no final project. However, there are numerous projects and assignments required in the various courses that give an opportunity for the student to apply their knowledge to broad problems.
Graduate Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPER 542</td>
<td>Decision Analysis using VFT</td>
<td>4</td>
</tr>
<tr>
<td>OPER 642</td>
<td>Decision Analysis under Uncertainty and Risk</td>
<td>3</td>
</tr>
<tr>
<td>OPER 638</td>
<td>Assessing Operational Cost and Risk</td>
<td>3</td>
</tr>
<tr>
<td>OPER 743</td>
<td>Decision Analysis Practice</td>
<td>3</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>===</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 Total Credit Hours</td>
<td></td>
</tr>
</tbody>
</table>

6.3.4. POs: GRADUATE CERTIFICATE IN COST CAPABILITY ANALYSIS

Our program outcomes (student knowledge/skills/abilities) produce graduate certificate conferees who exhibit:

1. Knowledge of the fundamental principles of multiobjective decision analysis including structuring decision problems, identifying objectives and effective ways to measure them, and analysis techniques for obtaining insight from the models developed.

2. A thorough understanding of risk assessment, risk analysis, and cost estimation as well as their impact on the decision making process in both military and industrial applications.

3. Awareness of the intricacies of working with multiple stakeholders, often with conflicting priorities and preferences, and the necessary facilitation skills for resolving those conflicts in order to move through the decision-making process.
6.4 GRADUATE CERTIFICATE IN DATA SCIENCE

6.4.1 STATEMENT OF PURPOSE

Data science is an interdisciplinary field focusing on scientific methods, processes, and systems to extract knowledge and insights from data in structured and unstructured forms. Data scientists use their data and analytic abilities to find and interpret rich data sources; manage large and complex datasets; create visualizations to aid in understanding data; build mathematical models using data; and present and communicate the data insights.

The demand for individuals with this knowledge is increasing rapidly, both inside and outside the Department of Defense (DoD). Consequently, the AFIT Data Science Certificate Program (DSCP) was designed to expedite this knowledge development.

The DSCP provides students with a thorough understanding of data science and its ability to operationalize data insights to enable evidence-based decision-making through military and industrial applications. Topics include the formulation of data-driven problems, application of advanced analytic techniques, managing large and complex data sets, and leveraging open source programming languages to create scalable, user-defined analytic products and applications.

In response to employer demand, higher-education institutions have begun offering more degree programs in data science and analytics (McKinsey, 2016). In fact, more than 80 university programs have been created over the past 10 years to provide undergraduate and graduate education focused on providing data science capabilities (INFORMS, 2015). And students have “flocked” to such opportunities, with the number of degrees granted in such fields growing by ~8% between 2010 and 2015. Still, demand for data scientists is growing faster than supply can meet with McKinsey estimating that the U.S. economy could be short as many as 250,000 data scientists by 2024 (McKinsey, 2016).

The demand within the DoD is just as strong. U.S. Army initially provided seed money to stand up a data science capability within ENS to advance their analytic capabilities and to properly prepare their operations research students attending AFIT. AFRL also provided 219 funding to ENS to provide data science education to their workforce. Furthermore, several reports have shown the increase demand of data science capabilities within the DoD. The Deputy Chief of Staff, Intelligence, Surveillance, and Reconnaissance stated the need to develop and leverage data science capabilities to expand the operational capability of the intelligence community (USAF ISR, 2016). The National Academies of Sciences published a report emphasizing the need to strengthen data science methods for DoD personnel and readiness missions (NAP, 2017). Moreover, AF/A9 is pushing to establish a data science cell starting FY2019 (Gallagher, 2017).

The DSCP supports this growing need of data science capabilities by producing qualified individuals to process, exploit, and disseminate insights across the DoD’s growing data collection and data science needs.
6.4.2 ADMISSION REQUIREMENTS

In order to be considered for admission to DSCP, candidates must meet the AFIT Graduate School of Engineering and Management requirements for admissions. These requirements include a completed bachelor’s degree in an appropriate engineering or scientific discipline (mathematics, physical science, engineering, or computer science are highly desirable) and a minimum grade point average of 3.0. Additionally, successful completion of undergraduate calculus I, II, and III is required. Moreover, several of the courses offered by the DSCP require candidates to have taken an introductory to probability and statistics class (i.e. STAT 583 Introduction to Probability and Statistics; STAT 587 Applied Probability and Statistical Analysis). Waivers to the stated requirements may be granted on an individual basis as approved by the Department of Operational Sciences, through the DSCP Program Manager.

6.4.3 DESCRIPTION OF THE CURRICULUM

DSCP is a graduate level program centered on the principles of integrating advanced analytic techniques, large and complex data sets, and computer programming. It offers both a theoretical foundation of data science techniques and the pragmatic application of the interdisciplinary skills necessary for effective application of such techniques to real world decisions. Furthermore, students that successfully complete the program will demonstrate the program’s outcomes by developing an operationalized analytic product to address a DoD need.

Certificate Completion Requirements

DSCP is designed to support part-time or full-time students looking to specialize in the data science domain. Students will train on open source programming languages and packages that are currently (or projected) supported on DoD systems, thus enabling students to quickly transition with gained data science skills in their immediate follow-on operational assignments. All students are expected to participate in DSCP via in-residence AFIT courses for consecutive quarters until completing the full certificate requirements. Students complete the Analysis Core and then either the Artificial Intelligence, Machine Learning or the Operational Analysis track. Students must attain a grade point average of at least 3.00 for all graded courses comprising the certificate.

Graduate Courses (*non-permanent classes)  Credit Hours

Analysis Core

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPER 679</td>
<td>Empirical Modeling</td>
<td>3</td>
</tr>
<tr>
<td>OPER 685</td>
<td>Applied Multivariate Analysis I</td>
<td>3</td>
</tr>
</tbody>
</table>

Artificial Intelligence, Machine Learning (Take 2)

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 623</td>
<td>Statistical Machine Learning</td>
<td>4</td>
</tr>
<tr>
<td>CSCE 823</td>
<td>Artificial Neural Networks</td>
<td>4</td>
</tr>
</tbody>
</table>

Operational Analysis (Take 2)

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPER 655</td>
<td>Text Mining</td>
<td>3</td>
</tr>
</tbody>
</table>
OPER 684  Quantitative Forecasting Techniques  3
OPER 785  Applied Multivariate Analysis II: Pattern Recognition  3

Timeline
A student must complete all required courses within a four-year time period.

6.4.4 POs: GRADUATE CERTIFICATE IN DATA SCIENCE

Our POs (student knowledge/skills/abilities) produce graduate certificate conferees who exhibit:
- Knowledge of the fundamental data science capabilities and pipeline.
- Mastery of key facets of data investigation, including data wrangling, cleaning, sampling, management, modeling, communication, and analytic reproducibility.
- Competency in employing algorithmic solutions to address data science problems.
- Prowess in applying software engineering practices to create and enable reproducible and scalable data analysis applications.
- Proficiency in applying statistical and machine learning methods to make sense out of data sets, both large and small.
- Aptitude for what analyses are possible given a particular data set, including both the state of the art of the field and inherent limitations.
- Fluency for speaking to disparate groups within an organization to implement data science applications and solutions.
- For further information on admission to the Data Science Certificate Program visit the Office of Admissions website at http://www.afit.edu/admissions or call (937) 255-6234 ext 3184.

For further information on the Data Science Certificate Program curriculum or the acquisition of graduates, please contact:

Raymond R. Hill, Ph.D., Program Director
Department of Operational Sciences
Air Force Institute of Technology
AFIT/ENS, Bldg 641
2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765
Voice: (937) 255-3636 ext 7469, DSN 785-3636 ext 7469
E-mail: raymond.hill@afit.edu
APPENDIX A: FACULTY AND RESEARCH INTERESTS

Dr. Darryl K. Ahner
Professor
Director, STAT for T&E Center of Excellence
Director, Center for Operational Analysis

Education:
Ph.D. – Boston University, Systems Engineering, 2005
M.S. – Rensselaer Polytechnic Institute, Applied Mathematics, 1999
B.S. – United States Military Academy, Mechanical Engineering (Aerospace), 1990

Research Interests:
Dynamic programming applications, queueing applications, mathematical control theory and model predictive control of complex systems, missile defense, combat modeling algorithm development, models for supply chain management

Dr. Jason R. Anderson, Lt Col
Assistant Professor
Military Deputy Head
Program Chair, Operations Management

Education:
Ph.D. – Air Force Institute of Technology, Logistics, 2016
M.S. – Air Force Institute of Technology, Logistics and Supply Chain Management, 2013
M.S.A. – Central Michigan University, 2009

Research Interests:
Transportation, logistics management, inventory, sourcing, operations management, simulation

Dr. Nathaniel D. Bastian, MAJ, USA
Adjunct Assistant Professor

Education:
Ph.D. – Pennsylvania State University, Industrial Engineering and Operations Research, 2016
M.Eng. – Pennsylvania State University, Industrial Engineering, 2014
M.S. – Maastricht University, Econometrics and Operations Research, 2009
B.S. – U.S. Military Academy, West Point, Engineering Management (Electrical Engineering) with Honors, 2008
Research Interests:
Multiple Objective Optimization, Stochastic Programming, Decision Analytics, Simulation, Statistical Computing, Applied Econometrics, Production Economics, Machine Learning, Graph Mining, Data Science

Dr. Trevor J. Bihl
Adjunct Assistant Professor

Education:
M.S. – Ohio University, Electrical Engineering, 2011
B.S. – Ohio University, Electrical Engineering, 2005

Research Interests:
Control systems, cyber security, power systems, sensor data exploitation, statistics, data mining, and signal processing

Dr. Bradley C. Boehmke
Adjunct Assistant Professor

Education:
Ph.D. – Air Force Institute of Technology, Logistics, 2015
M.S. – Air Force Institute of Technology, Cost Analysis, 2011
B.S. – North Dakota State University, Kinesiology, 2003

Research Interests:
Supply chain analytics and data science, big data analytics, organizational economics, resource orchestration, business intelligence, and operations software tool development

Dr. Timothy W. Breitbach, Maj
Assistant Professor

Education:
Ph.D. – Massachusetts Institute of Technology, Systems Engineering, 2017
M.S. – Air Force Institute of Technology, Logistics and Supply Chain Management, 2012
B.A. – University of Notre Dame, Political Science and History, 2005

Research Interests:
Supply chain finance, logistics, inventory and petroleum management, qualitative and quantitative supply chain analysis

Dr. Sarah E. Burke
Adjunct Assistant Professor

Education:
Ph.D. – Arizona State University, Industrial Engineering, 2016
M.S. – Arizona State University, Statistics, 2013
B.S. – University of Vermont, Mathematics, 2011
Research Interests:
Design of experiments, response surface methodology, statistical process monitoring, time series analysis, statistical design and analysis for multi-response systems

Dr. William N. Caballero, Capt
Adjunct Assistant Professor

Education:
Ph.D. – Air Force Institute of Technology, Operations Research, 2019
M.S. – Air Force Institute of Technology, Operations Research, 2017
B.S. – University of Houston, Industrial Engineering, 2011

Research Interests:
Mathematical programming, specifically bilevel programming and the development of accompanying algorithms and metaheuristics, game theory with an emphasis on modeling and solving frameworks representing departures from unexpected utility theory and rational decision makers to include cumulative prospect theory, learning in games, and mechanic design, adversarial frameworks for the application of the elements of national power

Dr. Lance E. Champagne
Assistant Professor

Education:
M.S. – Air Force Institute of Technology, Operations Research, 1999
B.S. – Tulane University, Biomedical Engineering and Mathematics, 1991

Research Interests:
Agent-based simulation, combat simulation, emergent system behavior

Dr. Frank W. Ciarallo
Associate Professor

Education:
Ph.D. – Carnegie Mellon University, Industrial Administration, 1993
M.S. – Carnegie Mellon University, Manufacturing and Operations Systems, 1988
B.S. – Carnegie Mellon University, Electrical Engineering, Engineering &Public Policy, 1986

Research Interests:
Dr. Bruce A. Cox, Lt Col
Assistant Professor
Division Chief, Operations Research

Education:
Ph.D. – Georgia Institute of Technology, Industrial Engineering, 2011
M.S. – Virginia Commonwealth University, Mathematics, 2006
B.S. – Worcester Polytechnic Institute, Mathematics, 1999

Research Interests:
Linear and convex optimization, robust optimization, optimal control

Dr. William A. Cunningham
Professor
Program Chair, Logistics and Supply Chain Management Master’s Program

Education:
Ph.D. – University of Arkansas, Economics, 1986
M.S. – Oklahoma State University, Economics, 1979
B.S.B.A. – Missouri Southern University, Economics, 1976

Research Interests:
Strategic mobility, cost/benefit analysis, econometric modeling, costing, privatization and A-76 studies, modal choice, network analysis, location analysis, supply chain management, RFID

Dr. Richard F. Deckro
Professor
Director, Future Operations Investigation Laboratory (FOIL)

Education:
D.B.A. – Kent State University, Decision Sciences, 1976
M.B.A. – Kent State University, Decision Sciences, 1973
B.S. – University at Buffalo, Industrial Engineering, 1972

Research Interests:
Information operations and information assurance, reconstruction and stabilization, measures of effectiveness and assessment, behavioral modeling including social networks, modeling fourth generation operations, counter insurgency and irregular warfare, applied mathematical programming and optimization, project and program management, modeling and analysis, space applications, campaign modeling, technology selection and management, scheduling, network models, advanced manufacturing methods, multi-criteria decision making, and decision analysis

Dr. John M. Dickens, Lt Col
Assistant Professor
Division Chief, Logistics and Supply Chain Management

Education:
Ph.D. – University of North Texas, Logistics Systems, 2018
M.M.A.S. – Air University, 2014
M.S. – Air Force Institute of Technology, Logistics and Supply Chain Management, 2011
B.S. – Air Force Academy, U.S. Military History, 2002

**Research Interests:**
Service-Dominant logic, value and value-creation, supply chain resilience, transaction cost economics, self-determination theory, resource based-view, experiments, survey, simulation methodologies

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**Dr. Matthew A. Douglas**
Adjunct Assistant Professor

**Education:**
Ph.D. – University of North Texas, Marketing, 2009
M.S. – Air Force Institute of Technology, Logistics Management, 2003
B.S. – Angelo State University, Mathematics, 1996

**Research Interests:**
Social sustainability in supply chains and transportation, ethics and ethical decision-making, management/technological innovation diffusion in organizations/supply chains, leading and sustaining transformation, cross-functional relationships/integration

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**Dr. Mark A. Gallagher**
Professor of Practice

**Education:**
Ph.D. – Air Force Institute of Technology, Operations Research, 1992
M.S. – Air Force Institute of Technology, Operations Research, 1986

**Research Interests:**
Applied statistics, forecasting, decision analysis, linear programming

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**Dr. Kevin J. Gaudette**
Adjunct Assistant Professor

**Education:**
Ph.D. – Indiana University, Kelley School of Business, Business, 2003
M.B.A. – Indiana University, Kelley School of Business, Decision Sciences, Operations Management, 2003
M.S. – Air Force Institute of Technology, Logistics Management, 1998
M.B.A. – Southern New Hampshire University, 1996
B.S. – University of Vermont, Mechanical (Biomedical) Engineering, 1990

**Research Interests:**
Supply chain design, distribution network optimization, sports analytics, process design, performance management, stochastic modeling, simulation
Dr. Alex J. Gutman
Adjunct Assistant Professor

Education:
M.S. – Wright State University, Mathematics, 2009
B.S. – Wright State University, Mathematics, 2007

Research Interests:
Design of experiments, computer experiments, supersaturated designs, response surface methodology, Bayesian statistics, machine learning, regression modeling, classification, and decision analysis

Dr. Shane N. Hall, Lt Col
Adjunct Assistant Professor

Education:
Ph.D. – University of Illinois at Urbana-Champaign, Industrial Engineering, 2006
M.S. – Air Force Institute of Technology, Operations Research, 2000
B.S. Brigham Young University, Mathematics, 1997

Research Interests:
Determining the optimal allocation/utilization of scarce or high-valued resources with specific applications in the health-care and military sectors

Dr. Benjamin T. Hazen
Adjunct Associate Professor

Education:
Ph.D. – Auburn University, Management, 2012
M.B.A. – California State University, 2007
M.A. – Gonzaga University, Organizational Leadership, 2006
B.S. – Colorado Christian University, Business Administration, 2004

Research Interests:
Empirical research in the areas of closed-loop supply chains, reverse logistics, remanufacturing, sustainability, innovation, and the supply chain management/information systems interface

Dr. Jeremy P. Hendrix
Adjunct Assistant Professor

Education:
Ph.D. – Air Force Institute of Technology, Systems, Engineering, 2015
M.S. – Air Force Institute of Technology, Systems Engineering, 2005
B.S. – Embry-Riddle Aeronautical University, Aviation Computer Science, 1995

Research Interests:
Systems engineering, operations research, VBA, data analysis, simulation
Dr. Raymond R. Hill, Jr.
Professor
Program Chair, Graduate Test and Evaluation Certificate
Program Chair, Operations Research Doctoral Program
Director, Manpower Personnel Modeling & Science of Test Research Laboratory

Education:
Ph.D. – The Ohio State University, Industrial and Systems Engineering, 1996
M.S. – Air Force Institute of Technology, Operations Research, 1988
B.S. – Eastern Connecticut State University, Mathematics, 1983

Research Interests:
Applied statistics, in particular the application of design of experiments methodologies to test and evaluation, mathematical optimization and in particular the use of heuristic search methods for addressing particularly hard problems, and applied simulation modeling and analysis with particular interests in the area of agent-based modeling and the validation of such models.

Dr. Timothy Holzmann, Maj
Assistant Professor

Education:
Ph.D. – Clemson University, Industrial Engineering, 2019
M.S. – Air Force Institute of Technology, Operations Research, 2009
B.A. – Cedarville University, Mathematics, 2004

Research Interests:
Combinatorial optimization, optimization under uncertainty, multiobjective optimization, decision support, stochastic modeling

Dr. Joseph R. Huscroft, Jr.,
Adjunct Assistant Professor

Education:
Ph.D. – Auburn University, Management, 2010
M.S. – Air Force Institute of Technology, Logistics Management, 2004
M.P.A – Troy State University, Public Admin/Personnel Management, 2002
B.S. – United States Air Force Academy, Behavioral Sciences, 1994

Research Interests:
Supply chain management, reverse logistics, reverse logistics metrics, innovation and flexibility in the supply chain, operations management, and information systems impact on the supply chain, transportation and distribution
Dr. Phillip R. Jenkins, Capt
Assistant Professor

Education:
Ph.D. – Air Force Institute of Technology, Operations Research, 2019
M.S. – Air Force Institute of Technology, Operations Research, 2017
B.S. – Ohio University, Mathematics, 2012

Research Interests:
Dynamic programming, approximate dynamic programming, Markov decision processes, stochastic programming, applied statistics, Machine learning, multiobjective optimization

Dr. Daniel Johnstone
Adjunct Assistant Professor

Education:
Ph.D. – Indiana University, Decision Sciences and Operations Management, 2009
M.B. – Indiana University, Operations Management, 2009
M.S. – Air Force Institute of Technology, Operations Research, 2002

Research Interests:
Inventory optimization, multi-echelon service parts supply networks, supply chain risk management, supply chain resilience, constraints-based management in production environments

Dr. Seong-Jong Joo
Professor
Program Chair, Logistics Doctoral Program

Education:
Ph.D. – Saint Louis University, Business Administration, 1995
M.B.A. - Saint Louis University, 1992
B.S. – Korea Air Force Academy, Operations Research, 1982

Research Interests:
Sourcing, transportation, performance measurement and benchmarking, inventory management

Dr. Kyle F. Kolsti
Adjunct Assistant Professor

Education:
Ph.D. – Air Force Institute of Technology, Aeronautical Engineering, 2012
M.S. – University of Washington, Civil Engineering, 1995
B.S. – University of Texas, Civil Engineering, 1993

Research Interests:
Computational methods for test data analysis, reliability and availability
Dr. Phillip M. LaCasse, LTC
Assistant Professor

Education:
Ph.D. – University of Wisconsin, Industrial Engineering, 2019
M.S. – University of Wisconsin, Industrial Engineering, 2010
B.S. – United States Military Academy, Mathematics, 2000

Research Interests:
Data science, probability and statistics, operations research, sports analytics

Dr. Brian J. Lunday
Associate Professor
Director, Joint Deployment & Distribution Environment (JDDE) Laboratory

Education:
Ph.D. – Virginia Polytechnic Institute, Industrial and Systems Engineering, 2010
M.S. – University of Arizona, Industrial Engineering, 2001
B.S. – U.S. Military Academy, West Point, Mechanical Engineering, 1992

Research Interests:
My theoretical research interests include math programming, game theoretic models, and algorithmic design for global optimization, whereas my application research interests include network design, network interdiction, network restoration, facility location, and resource allocation/assignment

Ms. Erin B. Lunday
Adjunct Instructor

Education:
Ed.D. – Wright State University, Organizational Studies, Projected Date 2020
M.A. – Virginia Polytechnic Institute, Political Science, 2010
B.S. – United States Military Academy, German Studies, 1995

Research Interests:
The mechanisms with which organizational identity and organizational culture are formed, the interaction between organizational leadership and culture, the effective means for modifying organizational culture

Dr. Daniel D. Mattioda
Adjunct Associate Professor

Education:
Ph.D. – The University of Oklahoma, Business Administration, Marketing/Supply Chain Management, 2007
M.S. – Air Force Institute of Technology, Logistics and Acquisition Logistics Management, 2002
B. S. – Embry Riddle Aeronautical University, Professional Aeronautics, 1997
Research Interests:
Collaboration and flexibility in the supply chain, reverse logistics, international logistics, and using simulation to model supply chain processes

Dr. John O. Miller
Associate Professor
Program Chair, Master of Science in Operations Research
Director, Combat Modeling Laboratory

Education:
Ph.D. – The Ohio State University, Industrial Engineering, 1997
M.S. – Air Force Institute of Technology, Operations Research, 1987
M.B.A. – University of Missouri at Columbia, 1983
B.S. – United States Air Force Academy, Biology, 1980

Research Interests:
Computer simulation, ranking and selection, agent based modeling, combat modeling, network centric warfare, high performance computing, applied statistics, and nonparametric statistics

Dr. James F. Morris
Adjunct Assistant Professor

Education:
Ph.D. – Air Force Institute of Technology, Philosophy in Operations Research, 2012
M.S. – Purdue University, Industrial Engineering, 2001
B.S. – Purdue University, Industrial Engineering, 1999

Research Interests:
Leveraging operations research, social network analysis, practical application within the intelligence community

Dr. Steven C. Oimoen
Adjunct Assistant Professor

Education:
Ph.D. – Air Force Institute of Technology, Computer Sciences, 2009
B.S. – Hawaii Pacific University, Computer Science, 1993
B.A. – Hawaii Pacific University, Mathematics, 1993

Research Interests:
Applied statistics, Design of Experiments

Dr. Francisco Ortiz, Jr.
Adjunct Assistant Professor

Education:
Ph.D. – Florida A&M University, Industrial Engineering, 2006
M.S. – Florida A&M University, Industrial Engineering, 2002
B.S. – Florida State University, Mechanical Engineering, 1998

Research Interests:
Design of experiments, advance regression techniques, multiple response optimization and
genetic algorithms, metallurgy and control systems

Dr. Carl R. Parson
Adjunct Assistant Professor

Education:
M.S. – Air Force Institute of Technology, Operations Research, 2010
M.B.A. – University of Phoenix, 2007
B.S. – Wright State University, Organizational leadership, 2004

Research Interests:
Dynamic programming, stochastic processes, military operations research, stochastic resource
allocation, optimization

Dr. David K. Peterson
Adjunct Assistant Professor

Education:
Ph.D. – University of North Carolina, Business Administration, 1987
M.S. – Air Force Institute of Technology, Logistics Management, 1982
B.S. – Iowa State University, Biology, 1978

Research Interests:
Readiness-based sparing (RBS) inventory management, sustainment planning and assessment for
systems-of-systems

Dr. Joseph J. Pignatiello, Jr.
Professor
Department Head

Education:
Ph.D. – The Ohio State University, Industrial and Systems Engineering, 1982
M.S. – The Ohio State University, Industrial and Systems Engineering, 1979
B.S. – University of Massachusetts, Mathematics, 1976

Research Interests:
Statistical process monitoring, change-point models, design and analysis of experiments,
reliability, statistical data analysis, robust design, six sigma methods
Dr. Edward A. Pohl
Adjunct Associate Professor

Education:
Ph.D. – University of Arizona, Systems and Industrial Engineering, 1995
M.S. – University of Arizona, Reliability Engineering, 1993
M.S. – Air Force Institute of Technology, Systems Engineering, 1998
B.S. – Boston University, Electrical Engineering, 1984

Research Interests:
Risk, reliability, engineering optimization, healthcare and supply chain risk analysis, decision making, quality

Dr. Adam D. Reiman
Assistant Professor

Education:
Ph.D. – Air Force Institute of Technology, Logistics, 2014
M.S. – Air Force Institute of Technology, Logistics Management, 2009

Research Interests:
Airlift metrics, routing, scheduling, and fuel efficiency; energy efficiency, supply and demand; value-focused thinking, heuristic search algorithms

Dr. Matthew J. Robbins
Associate Professor

Education:
Ph.D. – University of Illinois, Industrial Engineering, 2010
M.S. – Air Force Institute of Technology, Operations Research, 2005
B.S. – University of Arkansas, Computer Systems Engineering, 1999

Research Interests:

Dr. William F. Rowell
Adjunct Assistant Professor

Education:
Ph.D. – University of Texas at Austin, Operations Research, 1979
M.S. Stanford University, Operations Research, 1971
B.S. – United States Air Force Academy, Mathematics, 1970
Research Interests:
Cybersecurity test and evaluation, T&E of software intensive systems, automated software testing, T&E of autonomous systems

Dr. James R. Simpson
Adjunct Professor

Education:
Ph.D. – Arizona State University, Industrial Engineering, 1995

Research Interests:
Quality engineering, statistically designed experiments, response surface methods, statistical process control, robust regression methods, engineering statistics, simulation, operations research and supply chain management

Dr. Christopher M. Smith, LTC
Adjunct Assistant Professor

Education:
Ph.D. – University of Virginia, Systems Engineering, 2013
M.S.E. - University of Texas, Operations Research, 2007
M.S. – Missouri University of Science and Technology, Engineering Management, 2002
B.S. – United States Military Academy, Systems Engineering, 1997

Research Interests:
Decision analysis, risk analysis, data mining, network analysis, social media analysis

Dr. Daniel W. Steeneck
Adjunct Assistant Professor

Education:
Ph.D. – Virginia Polytechnic Institute and State University, Industrial and Systems Engineering, 2014
M.S. - Virginia Polytechnic Institute and State University, Industrial and Systems Engineering, 2009
B.S. - Virginia Polytechnic Institute and State University, Industrial and Systems Engineering, 2008

Research Interests:
Inventory management, remanufacturing, schedulig, service parts management, supply chain analytics, retail operations

Dr. Thomas P. Talafuse, Maj
Assistant Professor

Education:
Ph.D. – University of Arkansas, Industrial Engineering, 2016

**Research Interests:**
Reliability, reliability growth, optimization, stochastic processes, design of experiments, applied statistics, risk analysis

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**Dr. Steven N. Thorsen**
Adjunct Assistant Professor
Associate Director, STAT for T&E Center of Excellence

**Education:**
Ph.D. – Air Force Institute of Technology, Applied Mathematics, 2005
M.A. – East Carolina University, Mathematics, 1997
B.A. – Florida Atlantic University, Mathematics, 1991

**Research Interests:**
Information fusion, Classification theory, application of receiver operating characteristic (ROC) manifolds

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**Dr. Leonard F. Truett, III**
Adjunct Assistant Professor

**Education:**
Ph.D. – University of California, Aerospace Engineering, 2000
M.S. – Georgia Institute of Technology, Aerospace Engineering, 1992
B.S. – Georgia Institute of Technology, Aerospace Engineering, 1991

**Research Interests:**
Design and analysis of experiments

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**Dr. G. Geoffrey Vining**
Adjunct Professor

**Education:**
Ph.D. – Virginia Polytechnic Institute and State University, Statistics, 1988
M.S. – Virginia Polytechnic Institute and State University, Statistics, 1986
B.A.—University of Tennessee, Philosophy, 1981

**Research Interests:**
Use of experimental designs for quality improvement, response surface methodology, statistical quality control, regression analysis

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**Dr. Jeffery D. Weir**
Professor
Associate Department Head
Program Chair, Master of Science in Operations Analysis (IDE)

**Education:**
Ph.D. – Georgia Institute of Technology, Industrial Engineering & Operations Research, 2002
M.S. – Air Force Institute of Technology, Operations Research, 1995
M.A.S. – Embry Riddle Aeronautical University, Business Administration, 1992
B.E.E – Georgia Institute of Technology, Electrical Engineering, 1988

**Research Interests:**
Decision analysis, applied statistics, deterministic optimization

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Dr. Marcelo Zawadzki, BR, Lt Col
Assistant Professor
Program Chair, Cost Capability Analysis Certificate Program

**Education:**
D. Sc. - Technological Institute of Aeronautics/London School of Economics and Political Science, Operations Research, 2014
M.B.A. – Universidade Federal Fluminense, 2011
M.S. - Technological Institute of Aeronautics, Operations Research, 2009
B.S. – Brazilian Air Force Academy, Aeronautical Sciences, 1999

**Research Interests:**
Resource allocation against emerging threats, multi-criteria analysis
APPENDIX B: DEPARTMENT LEADERSHIP AND CURRICULUM CHAIRS (ENS)

Department Leadership

Department Head
Dr. Joseph J. Pignatiello, Jr.

Associate Department Head
Dr. Jeffery D. Weir

Military Deputy Head
Dr. Jason R. Anderson, Lt Col

Director, Center of Operational Analysis
Dr. Darryl K. Ahner

Director, STAT for T&E Center of Excellence
Dr. Darryl K. Ahner

Division Chiefs

Logistics Division
Dr. John M. Dickens, Lt Col

Operations Research Division
Dr. Bruce A. Cox, Lt Col

Program Chairs

MS in Logistics and Supply Chain Management
Dr. William A. Cunningham

MS in Logistics
Dr. Seong-Jong Joo

MS in Operations Research
Dr. John. O. Miller

MS in Operations Management
Dr. Jason R. Anderson, Lt Col

PhD (Operations Research)
Dr. Raymond R. Hill

PhD (Logistics)
Dr. Seong-Jong Joo

Graduate Cost Capability Analysis Certificate
Dr. Marcelo Zawadzki, LTC

Graduate Data Science Certificate
Dr. Raymond R. Hill

Graduate Supply Chain Management Certificate
Dr. John M. Dickens, Lt Col

Graduate Test and Evaluation Certificate
Dr. Raymond R. Hill
Active duty Air Force military and Air Force civilian students who have been assigned by Headquarter Air Force Personnel Center to attend AFIT are selected for a specific area of study based upon the needs of the Air Force. This specified Air Force requirement (quota) is identified by the Air Force Education Requirements Board (AFERB) and military personnel data system (MILPDS) by a 4-character numeric/alpha academic specialty code (ASC). Following are the ASCs supported by the Department of Operational Sciences, including MILPDS clear-text, further defined as needed.

**Doctor of Philosophy**

**Doctor of Philosophy - Logistics**

1ACY - LOGISTICS MANAGEMENT.

1AMC - BUS ADM/MGT, LOG, LOG FUN MGT.  Logistics Function Management.

1AMG – BUS ADM/MGT, LOGISTICS MANAGEMENT, SYSTEMS ANALYSIS.

1AMM - MAINTENANCE MANAGEMENT.

1AMN – NUCLEAR LOGISTICS MANAGEMENT.

1AMS - SUPPLY MANAGEMENT.

1AMY - BUS ADM/MGT, LOGISTICS MGT.  Logistics Management.

1ATY - BUS ADM/MGT, TRANSPORT MGT.  Transportation Management.

1CBF - FUEL DISTR TECH.  Fuels Distribution Technology.

**Doctor of Philosophy - Operations Research**

0YEY - OPERATIONS RESEARCH.

0YSY - OPS RES, STRAT AND TACT.  Operations Research, Strategic and Tactical Sciences.

6EDY – MATHEMATICS OF RESEARCH/BIOMETRICS/BIOSTATISTICS.  A study of the application of mathematical principles to the calculation of the life span of humans and statistical methods applied to biological processes.

6EMY – MATH OF RESRC-OPERTN RSCH.

6EOY – MATH OF RESRC-WPN SYSM EVAL.  A study of the application of mathematical concepts to provide an effective means of determining the value of a weapon system.
Master of Science

Master of Science in Logistics and Supply Chain Management

Operational Logistics Track (OL):

1ACY - LOGISTICS MANAGEMENT. (AFIT/ENS Note: In rare cases when there is an AFERB quota for 1ACY, the selectee would be assigned to AFIT/EN to pursue our Master of Science in Logistics and Supply Chain Management, normally in the academic specialty code 1AMY, OL track.)

1AMC - BUS ADM/MGT, LOG, LOG FUN MGT. Logistics Function Management. (AFIT/ENS Note: In rare cases when there is an AFERB quota for 1AMC, the selectee would be assigned to AFIT/EN to pursue our Master of Science in Logistics and Supply Chain Management, normally in the academic specialty code 1AMY, OL track.)

1AMG – BUS ADM/MGT, LOGISTICS MANAGEMENT, SYSTEMS ANALYSIS.

1AMS - SUPPLY MANAGEMENT.

1AMY - BUS ADM/MGT, LOGISTICS MGT. Logistics Management.

1ATY - BUS ADM/MGT, TRANSPORT MGT. Transportation Management.

Life Cycle Logistics Track (LC):

1AMJ – LIFE CYCLE LOGISTICS.

Nuclear Logistics Management (NL):

1AMN – NUCLEAR LOGISTICS MANAGEMENT.

Operational Maintenance Track (OM):

1AMM - MAINTENANCE MANAGEMENT.

Petroleum Management Track (PM):

1CBF - FUEL DISTR TECH. Fuels Distribution Technology.

Master of Science in Operations Research

0YEA - OPERATIONAL ANALYSIS. (AFIT/ENS Note: Air Force students selected by HQ AFPC for this ASC are encouraged to satisfy Operational Modeling emphasis requirements.)

0YEC - OPS RES CMD & CNTRL. Operations Research Command and Control.
0YET - OPS RES TEST & EVAL. Operations Research Operational Test and Evaluation.

0YEY - OPERATIONS RESEARCH.

0YSY - OPS RES, STRAT AND TACT. Operations Research, Strategic and Tactical Sciences. (AFIT/ENS Note: Air Force students selected by HQ AFPC for this ASC are encouraged to satisfy Operational Modeling emphasis requirements.)

6EDY – MATHEMATICS OF RESEARCH/BIOMETRICS/BIOSTATISTICS. A study of the application of mathematical principles to the calculation of the life span of humans and statistical methods applied to biological processes.

6EMY – MATHEMATICS OF RESEARCH/OPERATIONS RESEARCH

6EOY – MATH OF RESRC-WPN SYSM EVL. Weapon Systems Evaluation (Mathematics). (AFIT/ENS Note: Air Force students selected by HQ AFPC for this ASC are encouraged to satisfy Operational Modeling emphasis requirements.)

Master of Science in Operations Management
Logistics and Air Mobility Track (LOGAIR, Ft. Dix) and

1AKZ – OPERATIONS MANAGEMENT

Master of Science in Logistics (IDE)

1AMY - BUS ADM/MGT, LOGISTICS MGT. Logistics Management.

Master of Science in Operations Analysis (IDE)

0YEA - OPERATIONAL ANALYSIS.
APPENDIX D: ENS THESIS POLICY

Department of Operational Sciences
POLICY ON MASTERS’ THESSES

1. Background

The Department of Operational Sciences (AFIT/ENS) administers two master’s degree programs that require theses: Operations Research (OR.MS) and Logistics and Supply Chain Management (LSCMGT.MS). The goal of the OR program is to produce analysts who can provide senior Air Force and Department of Defense (DoD) leadership with the insights and support needed to make sound decisions. The goal of the LSCMGT program is to develop logistics managers who can efficiently use scarce resources and effectively coordinate and direct the myriad of functional areas necessary to achieve the logistics mission.

To effectively contribute as analysts or logistics managers, OR and LSCMGT graduates must be able to focus on the right problems, select appropriate analysis techniques, properly interpret the results, and communicate them in a meaningful way.

The thesis effort provides an opportunity to apply, enhance, and evaluate the skills gained during the coursework portions of the OR and LSCMGT programs. The thesis is a scholarly document that provides a record of a student’s independent efforts in addressing a significant problem. The primary purpose of the thesis is for the student to conduct a research project of adequate complexity to demonstrate competence in and understanding of the various aspects of the research process. These are some of the important goals:

- Conduct sound research in an appropriate field—define and limit a problem, find and review the pertinent literature, develop a rigorous approach to the solution, develop a realistic research schedule, carry out the steps necessary to solve the problem, and recognize and respond to problems that can arise.
- Prepare an effective research thesis that presents the results of the study—the problem addressed, the methodology used, the results obtained, the conclusions reached, and the recommendations developed.
- Provide a defense of the thesis. As opposed to offering an informative briefing, the student is expected to defend the points of the thesis in the thesis defense.

The thesis is a combination of both process and product. The process involves planning, conducting, and managing research activities. The product requires the writing of a report that describes the research conducted. Students do not conduct their research completely independently—they learn through the instruction and guidance of advisors and other faculty members.

The student begins the thesis process by identifying and defining a problem of interest. Faculty members are good sources of viable research problems. The process normally continues with an extensive literature review of related progress and contributions. As the student learns more about the problem area, he or she should consider one or more ways to solve the specific problem of interest. Using at least one of these methods, the student will generally solve the
problem of interest and validate the solution(s) through analysis or empirical data. Finally, any conclusions and recommendations made should be based on the insights gained throughout the entire research effort.

Key to this process is the focus on the problem, not the solution technique. Far too many students become enamored with a specific analytic methodology and then attempt to make the problem conform. Failure to focus on the problem undermines the objectives of sound research because “to a man with a hammer, every problem looks like a nail.”

This document clarifies ENS-specific thesis requirements. The most current Style Guide for AFIT Theses and Dissertations should be consulted for general guidance and requirements, especially relating to the format and submission of the thesis document.

2. Topic and Committee Selection

Each student is responsible for selecting a thesis topic and forming an appropriate thesis committee. To help in selecting an appropriate topic, ENS has established several means of presenting potential thesis topics to the students.

- During the first or second quarter, ENS faculty members present their current research efforts or interests, including possible follow-on topics from previous student research. The department may identify a few of these topics as higher priority because of their potential impact, and they may be briefed to students before any non-priority topic can be selected. In addition, funded topics may be briefed before any non-funded topics.
- The department maintains an electronic thesis database containing descriptions of approved topics. (A topic becomes approved only after faculty members indicate a willingness to serve as an advisor for that topic.)
- Students may also develop their own topics but are responsible for finding faculty members to serve as advisors.

Discussions with several faculty members about various topics may be necessary before the topic and advisor are finalized. Discussing potential topic areas with a variety of potential advisors can help the student clarify the research issues and determine the advisor-student match that will provide the best result. A successful match is vital for success because the student-advisor relationship will continue throughout the full program at AFIT.

After advisor and topic are finalized, the student and advisor then discuss potential thesis committee members. A student’s thesis committee consists of the advisor and at least one other faculty member, who serves as the co-advisor or reader. The student, with the consent of the advisor, contacts potential committee members to seek their concurrence. Committee members must have expertise and experience in the relevant technical areas and disciplines required for the thesis research. Co-advising may sometimes be desirable when the expertise of two faculty members is equally necessary to the successful conduct of the research. Faculty members from departments other than ENS may serve as thesis advisors and committee members for ENS students. However, ENS is responsible for determining if the thesis satisfies the research requirements of the graduate degree. Therefore, prior to forming a committee with an advisor from outside ENS, the student must obtain ENS Department Head approval, and an ENS faculty member must be designated as the ENS representative. Students seeking approval for an advisor
external to the department should provide the Logistics or Operations Research division chief with the proposed topic and advisor. After the respective division reviews the request, it will be forwarded to the ENS Department Head for an approval decision. The possible committee combinations are:

- Advisor from ENS and one or more readers
- Two co-advisors (at least one from ENS), with or without readers
- Advisor from outside ENS, ENS representative (reader), and other readers if desired

Students should provide the ENS Graduate Advisor with the thesis title and names of advisor(s) and reader(s) by the fifth week of their fourth quarter (see attachment 1). The ENS Graduate Advisor will consolidate this information for division review.

3. Thesis Proposal

The thesis proposal provides an overview of the thesis research project, including a statement of the problem to be addressed, a plan for conducting the research, a preliminary assessment of the outcome and any additional items required by a student’s committee. Although thesis research proposals can be described in a variety of ways, one of the most useful is to think of it as a contract between you (the student) and the school. It describes what you intend to do, and it indicates the school’s approval of the research you propose to conduct. A good proposal can reduce wasted effort, ensure a steady pace of progress, and provide a quality product in the thesis report.

The thesis proposal must meet the requirements of the student’s thesis committee. As a minimum, the proposal must accomplish the following:

- Define the topic clearly and succinctly
- Explain significance of the topic
- Describe previous work in the topic area
- Explain expected contribution of the thesis
- Outline scope of the thesis
- Establish a timeline of research milestones

4. Administrative Documentation

**Thesis Credit:** There are 12 credit hours associated with the thesis, usually registered under the OPER 799 course designator. If the thesis advisor is not from ENS, these credit hours can be registered under a course designator appropriate for the advisor’s department. For example, an advisor from the Department of Engineering Physics (ENP) may wish to have the thesis registered under PHYS 799. The 12 credit hours also can be allocated among two different course designators if agreed upon by the committee (e.g., with co-advisors from ENS and ENP, 6 hours could be registered under OPER 799 and 6 under PHYS 799).

**Thesis Proposal Approval:** The thesis committee, course numbers under which the thesis credits are to be registered, and committee acceptance of the thesis proposal must be documented on the “Thesis Proposal Approval Form” (see Attachment 1) and submitted to the student’s class
advisor by the fifth week of the fourth quarter. When a change in the scope of the thesis warrants a change in the thesis committee, this form must be revised and resubmitted.

**Thesis Approval:** The “Thesis Approval Form” (see Style Guide for AFIT Theses and Dissertations) is included as the third page of the final thesis document. The thesis committee uses this form to signify that a student has successfully completed all thesis requirements. An ENS version of the “Thesis Approval Form” with space for the thesis grade (see Attachment 2) is submitted to the thesis advisor at the time of the thesis defense. ENS maintains this form for at least one year.

**Sponsor Information:** Complete information about the thesis sponsor must be included on the SF-298 that becomes the last page of the thesis. (The sponsor is the person or organization for whom the thesis research has been performed, regardless of monetary or other resource support provided.) The SF-298 includes the name of the sponsor’s point of contact, office symbol, phone number, and complete mailing address. Two additional copies of the SF-298 must also be turned in to the department.

**Distribution Statements and Release Checklists:** The appropriate DoD distribution statement must be placed on the flyleaf title page of the thesis and SF-298. These statements, and explanations of their use, are presented in the Style Guide for AFIT Theses and Dissertations. In addition, the student must complete an “AFIT Public Release Review Checklist” (included in the Style Guide for AFIT Theses and Dissertations) to certify that the thesis is releasable to the general public; otherwise, the thesis must reflect that distribution is restricted. The thesis advisor reviews the checklist and signs as Information Originator. The checklist is then forwarded to the advisor’s department head for review and signature as the Certification Official. AFIT/PA or OASD/PA serves as the final Release Authority.

**5. Thesis Completion Timeline**

An important student responsibility in managing the thesis project is establishing and maintaining a realistic schedule. The following paragraphs list the general quarterly milestones each student should strive to attain. Specific deadlines, procedures, and requirements will be communicated to the students through their faculty class advisors.

- **First and second quarters (Fall and Winter):** Students should consider how lessons learned from personal experience, classes, seminars, and projects might relate to a research effort. General topic areas and possible committee members should be considered. Consultation with students in the previous year’s class is advised; attendance at the thesis defense of at least one graduating student is also required.

- **Third quarter (Spring):** Each student must select a thesis topic and thesis advisor not later than the end of the third quarter. (The full committee should be formed as soon as possible, but some readers might not commit until they know their advising loads.) Students should discuss potential electives with their thesis committees to ensure coursework best supports their thesis research and academic goals.

- **Fourth quarter (Summer):** Any student without a thesis topic and advisor will meet with the Department Head no later than the end of the first week of the quarter. Each
student must complete a thesis proposal and submit documentation of committee approval by the fifth week of the quarter. Students should make substantial progress on their thesis research during this quarter.

- **Fifth quarter (Fall):** The specific milestones for each thesis will generally differ, but much of the thesis research should be completed in this quarter. Reasonable goals include completion of high-quality drafts relating to the problem statement, literature review, data collection, and the modeling or analysis procedures to be used.

- **Sixth quarter (Winter):** A final, high-quality and well-edited draft of the complete thesis should be turned in to the committee no later than the last day of the fifth week. At the same time, a copy of this document should be submitted to the ENS Graduate Advisor to ensure students have properly formatted the document. Before submitting the final draft, the student will provide preliminary drafts to the committee for review and comment. The student should also schedule the defense with their thesis committee and coordinate the time of the defense with the department’s Graduate Advisor at least one week in advance. Defenses for theses being considered for awards will be scheduled no later than the eighth week, with all defenses completed by the end of the ninth week.

6. Thesis Defense

The thesis defense is a formal (service dress or equivalent attire) oral presentation of the student’s research accomplishments. Defenses for theses being considered for awards will be scheduled no later than the eighth week, with all defenses completed by the end of the ninth week. A final copy of the complete thesis must be available at the defense. The student should defer to the preferences of the research committee concerning the details of the defense, but in general:

- An e-mail defense announcement (approved by the student’s advisor) giving the student’s name; time, date and location of the defense; and a brief abstract of the research should be sent to AFIT/PA, research sponsors, and other appropriate invitees at least one week prior to the defense. Advisors will send email invitations to ENS faculty and students.

- The defense should provide a brief motivation and background for the research. The focus should be on problem formulation, interpretation, academic defense of the approach and concepts and research accomplishments.

- The defense should be timed for no more than 35 to 45 minutes to allow time for questions from the committee and other attendees. The student should schedule the room for the defense for two hours to provide adequate time for questions and deliberation.

- The student should consider the audience technically literate, but not intimately familiar with the details of the research topic.

- The student should incorporate effective visual aids.

- In keeping with the academic nature of the thesis defense, it is not appropriate for spouses (or “significant others”) to be in attendance unless that person is also working in the same field of study as the student and thus would have a legitimate professional interest in the defense. Furthermore, it is not appropriate to have refreshments at the defense. The student may provide refreshments after the defense, but they are certainly not required.

It is not uncommon for a committee to recommend revisions to the thesis during a successful defense. If so, the student must update the thesis, make final copies, and complete all
administrative requirements. If the committee judges the defense to be unsatisfactory, the student must defend at a later date.

7. Thesis Evaluation

In evaluating a thesis, the student’s committee first determines if the thesis meets the following minimal criteria for acceptability:

- **Technically correct**
  - Analysis should be performed correctly
  - Relevant concepts should be used and described correctly
  - Ideas should be logically developed
- **Complete**
  - Clear problem description
  - Appropriate discussion of relevant concepts and a full literature review
  - Description of approach, including alternatives and reasons for the particular approach selected
  - Description of analysis performed
  - Appropriate discussion of results and their implications
- **Adequately communicates concepts and results**

If a thesis does not meet these standards, it will be judged *Not Acceptable* by the thesis committee.

The grade assigned to a thesis will depend on how well these criteria are satisfied by the final thesis document, and on the contributions made by the student throughout the entire thesis process. The committee will also consider the following general evaluation criteria:

- Strength of the contributions made by the thesis to the sponsor or field
- Independence and initiative in developing ideas and performing research
- Overall correctness and completeness of the work throughout the thesis process
- Quality of the written document (preliminary drafts as well as the final copy) in communicating ideas clearly and concisely and being readily intelligible and of use to the sponsors, thesis advisor, and others in the field
- Quality of the oral defense

Attachment 3 serves as a guide for the committee to use in determining the letter grade of the thesis. While a grade of C or C+ is permitted, they will rarely be given. The thesis advisor is responsible for coordinating the student’s thesis grade with the rest of the committee. Although the committee generally determines the letter grade shortly after the defense, the grade may not be communicated to the student until the final document is formally submitted.

8. Other Requirements

Students are responsible for ensuring that all department and EN requirements for theses are completed prior to graduation. Again, the *Style Guide for AFIT Theses and Dissertations* should be consulted for other specific requirements not covered in this policy statement. Students must
also comply with all department GRP and graduation requirements listed in the *ENS Thesis Instructions and the Checklist for Graduating Masters Students from ENR* as well as any others that may be announced. Failure to complete administrative details, although seemingly trivial, can prevent on-time graduation.

2 Attachments:
1. Thesis Proposal Approval Form
2. Thesis Evaluation Guidelines
Attachment 1 – Actual Form is a Fillable PDF

APPROVAL OF THESIS PROPOSAL

Student Name:       Grad Class:

Thesis Title:

Date:

Sponsor:

Weapon Systems Correlation
 (if applicable):

We accept the attached proposal as defining a thesis effort that satisfies the objectives stated in the Department of Operational Sciences Policy on Master’s Theses.

The 12 hours of graded thesis credit will be registered under the following course number:

XXXX 799 (12 hours)

***NOTE: If you wish to do research outside of ENS, you must coordinate with an ENS faculty member as your Reader. You must also have your request approved by the ENS Department Head.

Committee Name/Title/Department Signature

Advisor

Co-Advisor/ Reader

Dept Head
(Required for Research Outside Of the Dept)

The advisor information has been entered into Colleague/WebAdvisor.

Training Administrator
### THESIS EVALUATION WORKSHEET

<table>
<thead>
<tr>
<th>CRITERION</th>
<th>A (40)</th>
<th>A- (37)</th>
<th>B+ (34)</th>
<th>B (31)</th>
<th>B- (28)</th>
<th>Weight</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONTRIBUTIONS TO SPONSOR OR FIELD:</strong></td>
<td>Exceptional, Original (Possible Journal Publication?)</td>
<td>Significant, Important (Possible Conf. Presentation?)</td>
<td>Worthwhile</td>
<td>Modest</td>
<td>Few</td>
<td>(0.25)</td>
<td></td>
</tr>
<tr>
<td><strong>INITIATIVE AND INDEPENDENCE IN GENERATING IDEAS AND PERFORMING RESEARCH:</strong></td>
<td>Self-directed and Self-starting</td>
<td>Infrequent Direction or Prompting Needed</td>
<td>Typical Thesis Partnership</td>
<td>Frequent Direction or Prompting Needed</td>
<td>Careful Supervision Needed</td>
<td>(0.25)</td>
<td></td>
</tr>
<tr>
<td><strong>ANALYTICAL PROFICIENCY DEMONSTRATED:</strong></td>
<td>Exceptional, Innovative, Authoritative</td>
<td>Very Good, Insightful, Above Average</td>
<td>Good, Skillful, Capable</td>
<td>Fair, Modest, Below Average</td>
<td>Weak, Somewhat Limited</td>
<td>(0.20)</td>
<td></td>
</tr>
<tr>
<td><strong>QUALITY OF WRITTEN THESIS:</strong></td>
<td>Exceptional, Clear, Concise, A Pleasure to Read, Virtually Flawless</td>
<td>Very Good, Well-Written, Above Average, Minor Infrequent Editing Required</td>
<td>Lucid, Logically Developed, Average/Ongoing Editing Required</td>
<td>Rough, Wordy, Loosely Structured, Major/Frequent Editing Required</td>
<td>Difficult to Read, Unclear, Unstructured, Extensive Research or Revisions Required</td>
<td>(0.20)</td>
<td></td>
</tr>
<tr>
<td><strong>QUALITY OF ORAL DEFENSE:</strong></td>
<td>Exceptional, Clear, Concise, Informative</td>
<td>Very Good, Well-Briefed, Above Average</td>
<td>Lucid, Logically Developed</td>
<td>Rough, Rambling, Loosely Structured</td>
<td>Difficult to Follow, Unclear, Unstructured</td>
<td>(0.10)</td>
<td></td>
</tr>
</tbody>
</table>
| **OVERALL EVALUATION OF THESIS:** | Truly Exceptional, Commanding, Award Quality | Clearly Excellent, Above Average | Good, Typical, Correct, Appropriate | Fair, Adequate (Acceptable but Somewhat Lacking) | Marginally Acceptable (Obvious Limitations) | TOTAL | WGTQ.

GRADE COMPUTATION BASED ON TOTAL WEIGHTED SCORE:

- 3.05 < Score < 4.00: A
- 3.55 < Score < 3.05: A-
- 3.15 < Score < 3.50: B+
- 2.65 < Score < 3.15: B
- 2.00 < Score < 2.65: B-
- Score < 2.00: Not Acceptable

NOTES:

1. This worksheet is provided for the guidance of the faculty and is intended to describe the characteristics of those typically receiving the indicated grades. Faculty may assign weights and use this worksheet at their discretion in assigning grades.
2. Grades of A- and B+ should be interpreted as good grades and are generally awarded for typical thesis efforts.
APPENDIX E: ENS GRADUATE RESEARCH PAPER POLICY

Department of Operational Sciences
POLICY ON GRADUATE OPERATIONAL SCIENCES RESEARCH PAPERS

1. Background

The graduate research paper (GRP) provides an opportunity to apply, enhance, and evaluate the skills gained during the coursework portions of the Operational Sciences IDE programs. The GRP is a scholarly document that provides a record of a student’s independent efforts in addressing a significant problem. The primary purpose of the GRP is for the student to conduct a research project of adequate complexity to demonstrate competence in and understanding of the various aspects of the research process. These are some of the important goals:

- Conduct sound research in an appropriate field—define and limit a problem, find and review the pertinent literature, develop a realistic research schedule, carry out the steps necessary to solve the problem, and recognize and respond to problems that can arise.
- Prepare an effective research report that presents the results of the study—the problem addressed, the methodology used, the results obtained, the conclusions reached, and the recommendations developed.

The GRP is a combination of both process and product. The process involves planning, conducting, and managing research activities. The product requires the writing of a report that describes the research conducted. Students do not conduct their research completely independently—they learn through the instruction and guidance of an advisor and other faculty members.

The student begins the GRP process by identifying and defining a problem of interest. The process normally continues with a literature review of related progress and contributions. As the student learns more about the problem area, he or she will choose an appropriate way to present the problem. An appropriate GRP: may cover an appropriate project from start to finish; may represent a specific portion of an ongoing research project; may involve synthesis of work from a number of courses resulting in a capstone project; may involve some other appropriate research activities. Finally, any conclusions and recommendations made should be based on the insights gained throughout the entire research effort.

This document clarifies ENS-specific GRP requirements. The most current Style Guide for AFIT Theses and Dissertations as well as past GRPs may be consulted for general guidance and requirements, especially relating to the format. Attachment 1 gives an example of what a GRP might include but is not the only possibility. It is important to remember that the faculty advisor alone determines what is and is not a graduate research paper.

2. Topic and Advisor Selection

Each student is responsible for selecting a GRP topic and selecting an appropriate advisor. An
appropriate advisor is an ENS faculty member. If research is to be done with an advisor not from the ENS faculty, this research must be approved by the Department Head and a committee must be formed with at least one member being on the ENS faculty. To help in selecting an appropriate topic, ENS faculty members will present their current research efforts or interests, including possible follow-on topics from previous student research at a symposium or while teaching a course at Ft Dix. Students may also develop their own topics but are responsible for finding faculty members to serve as advisors.

Students typically approach a potential advisor with a general topic area—and sometimes a specific topic—in mind. Discussions with several faculty members about various topics may be necessary before the topic and advisor are finalized. Discussing potential topic areas with a variety of potential advisors can help the student clarify the research issues and determine the advisor-student match that will provide the best result. A successful match is vital for success because the student-advisor relationship will continue throughout the full program at AFIT.

3. Graduate Research Paper Proposal

The GRP proposal provides an overview of the research project, including a statement of the problem to be addressed, a plan for conducting the research, and a preliminary assessment of the outcome. Although GRP research proposals can be described in a variety of ways, one of the most useful is to think of it as a contract between you (the student) and the school. It describes what you intend to do, and it indicates the Department’s approval of the research you propose to conduct. A good proposal can reduce wasted effort, ensure a steady pace of progress, and provide a quality product in the paper.

The GRP proposal must meet the requirements of the student’s advisor. Typically, proposals accomplish the following:

- Define the topic clearly and succinctly
- Explain significance of the topic
- Describe previous work in the topic area
- Explain expected contribution of the GRP
- Outline scope of the GRP
- Estimate timeline of research milestones

Acceptance of the GRP proposal must be documented on the “GRP Proposal Approval Form” (see Attachment 2) and submitted to the student’s class advisor by the end of the second quarter. When a change in the scope of the GRP warrants a change in the GRP committee, this form must be revised and resubmitted.

4. Graduate Research Paper Completion Timeline

An important student responsibility in managing the GRP is establishing and maintaining a realistic schedule. The following paragraphs list the general milestones each student should strive to attain. Specific deadlines, procedures, and requirements will be communicated to the students through their faculty and class advisors.

- **Short and First quarters**: Students should consider how lessons learned from personal
experience, classes, seminars, and projects might relate to a research effort. General topic areas and possible advisors should be considered. Consultation with students in the previous year’s class is advised.

- **Second quarter**: Each student must complete a GRP proposal and submit documentation of advisor approval by the end of the second quarter. This will be done in conjunction with the OPER 500 Seminar course/LOGM 601 depending on your program. Students should discuss potential electives with their GRP advisor to ensure future coursework best supports their research and academic goals. Any student without a GRP topic and advisor by the end of the second quarter will meet with the Department Head no later than the end of the first week of the third quarter to determine a GRP topic and advisor.

- **Third quarter**: The specific milestones for each GRP will generally differ, but your literature review should be complete, as model formulation should have begun during this quarter. Reasonable goals include completion of high-quality drafts relating to the problem statement and any modeling or analysis procedures if used.

- **Fourth quarter**: A final, high-quality and well-edited draft of the complete GRP should be turned in to the advisor no later than the last day of the seventh week. Before submitting the final draft, the student will provide preliminary drafts to the advisor for review and comment. Each program will hold a research day where all GRPs for that program will be presented. All faculty and students are invited to the research days regardless of program.

The “GRP Approval Form” is used by the advisor to signify that a student has successfully completed all GRP requirements. Attachment 3 has a copy of the form which is submitted to the GRP advisor at the time of the presentation. ENS maintains this form for at least one year.

5. **Graduate Research Paper Evaluation**

In evaluating a GRP, the student’s advisor first determines if the GRP meets the following minimal criteria for acceptability:

- **Technically correct**
  - Analysis should be performed correctly
  - Relevant concepts should be used and described correctly
  - Ideas should be logically developed

- **Complete**
  - Clear problem description
  - Appropriate discussion of relevant concepts and a literature review
  - Description of approach selected
  - Description of any analysis performed
  - Appropriate discussion of results and their implications

- **Adequately communicate concepts and results**

If a GRP does not meet these standards, it will be judged *Not Acceptable* by the advisor.

The grade assigned to a GRP will depend on how well these criteria are satisfied by the final document, and on the contributions made by the student throughout the entire process. The advisor will also consider the following general evaluation criteria:
- Strength of the contributions made by the GRP
- Independence and initiative in developing ideas and performing research
- Overall correctness and completeness of the work throughout the process
- Quality of the written document (preliminary drafts as well as the final copy) in communicating ideas clearly and concisely and being readily intelligible and of use to others in the field

Grades of A- and B+ should be interpreted as good grades and are generally awarded for typical GRP efforts. Only exceptional work will receive a grade of A.

Attachment 4 serves as a guide for the advisor to use in determining the letter grade of the GRP.

6. Other Requirements

Students are responsible for ensuring that all department and EN requirements for theses are completed prior to graduation. Again, the Style Guide for AFIT Theses and Dissertations should be consulted for other specific requirements not covered in this policy statement. Students must also comply with all department GRP and graduation requirements listed in the ENS Thesis Instructions and the Checklist for Graduating Masters Students from ENR as well as any others that may be announced. Failure to complete administrative details, although seemingly trivial, can prevent on-time graduation.

2 Attachments:
1. GRP Proposal Approval Form
2. GRP Evaluation Guidelines
Attachment 1 – Actual Form is a Fillable PDF

APPROVAL OF GRP PROPOSAL

Student Name: Grad Class:
Thesis Title:

Date:

Sponsor:

Weapon Systems Correlation
(if applicable):

We accept the attached proposal as defining a thesis effort that satisfies the objectives stated in the Department of Operational Sciences Policy on Master’s Theses.

The 6 hours of graded thesis credit will be registered under the following course number:

LOGM 791 (6 hours)

Committee Name/Title/Department Signature

Advisor

Co-Advisor
(if applicable)

The advisor information has been entered into Colleague/WebAdvisor.

Training Administrator
### GRADUATE RESEARCH PAPER EVALUATION WORKSHEET

<table>
<thead>
<tr>
<th>CRITERION</th>
<th>GRADE (POINTS)</th>
<th>Weight</th>
<th>Score</th>
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<tbody>
<tr>
<td><strong>CONTRIBUTIONS TO SPONSOR OR FIELD:</strong></td>
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<tr>
<td>Significant, Original (Possible Journal/</td>
<td>Good, Skilled, Capable</td>
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<tr>
<td>Important (Possible Conf. Presentation)</td>
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<tr>
<td>Worthwhile</td>
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<td>Modest</td>
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<tr>
<td><strong>INITIATIVE AND INDEPENDENCE IN GENERATING IDEAS AND PERFORMING RESEARCH:</strong></td>
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<tr>
<td>Self-directed and Self-starting</td>
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<tr>
<td>Intensive Direction or Prompting Needed</td>
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<td>Typical GRP Partnership</td>
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<td>Frequent Direction or Prompting Needed</td>
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<td>Careful Supervision Needed</td>
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<td><strong>ANALYTICAL PROFICIENCY DEMONSTRATED:</strong></td>
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<td></td>
</tr>
<tr>
<td>Exceptional, Innovative, Authoritative</td>
<td>Fair, Adequate</td>
<td></td>
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<tr>
<td>Very Good, Insightful, Above Average</td>
<td>Acceptable (Acceptable with minor revisions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good, Skilled, Capable</td>
<td>Acceptable (Acceptable but with limited revisions)</td>
<td></td>
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<tr>
<td>(0.20)</td>
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<tr>
<td><strong>QUALITY OF WRITTEN GRP:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exceptional, Clear, Concise, A Pleasure to Read</td>
<td>Good, Typical, Correct</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtually Flawless</td>
<td>Acceptable (Acceptable with minor revisions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Good, Well-Edited, Above Average, Minor/</td>
<td>Acceptable (Acceptable with limited revisions)</td>
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<td>Difficult to Read, Unclear, Unstructured, Extensive Rework or Revisions Required</td>
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<tr>
<td><strong>OVERALL EVALUATION OF GRP:</strong></td>
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</tr>
<tr>
<td>Truly Exceptional (Commandant's Award Quality)</td>
<td>Good, Typical, Correct</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clearly Excellent, Above Average</td>
<td>Acceptable (Acceptable with minor revisions)</td>
<td></td>
<td></td>
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<tr>
<td>Good, Typical, Correct</td>
<td>Acceptable (Acceptable with limited revisions)</td>
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<td>Acceptable (Acceptable with minor revisions)</td>
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<tr>
<td>TOTAL WGT. SCORE</td>
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### GRADE COMPUTATION BASED ON TOTAL WEIGHTED SCORE:

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<th>Score Range</th>
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<td>2.70 &lt; Score &lt; 2.85</td>
<td>B-</td>
</tr>
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<td>2.85 &lt; Score &lt; 3.15</td>
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<td>B+</td>
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<td>A-</td>
</tr>
<tr>
<td>Score &lt; 3.90</td>
<td>A</td>
</tr>
</tbody>
</table>

### NOTES:

1. This worksheet is provided for the guidance of the faculty and is intended to describe the characteristics of GRPs typically receiving the indicated grades. Faculty may assign weights and use this worksheet at their discretion in assigning grades.

2. Grades of A- and B+ should be interpreted as good grades and are generally awarded for typical GRP efforts.
APPENDIX F: FACULTY PIPELINE ASSIGNMENT INFORMATION

The Department of Operational Sciences needs officers to fill faculty slots on a recurring basis. The Department encourages students who do well in their master’s program to consider the opportunity of obtaining a Ph.D. as an Air Force assignment either in residence at AFIT or at a well-recognized civilian university or AFIT resident program. The selection process is competitive and begins approximately 12-18 months before the school start date for selected officers. Selectees spend three years completing their Ph.D. and then have a four-year commitment to teach at AFIT.

Interested AF officers are encouraged to both contact the appropriate Department of Operational Sciences Division Chief (at DSN 785-3636 ext 2549; commercial 937-255-3636 ext 2549) and their career field assignment officer or development team to express their interest and for further details. The Division Chiefs for the Logistics Division and Operations Research Division each review their respective applicants’ transcripts and GRE or GMAT scores (test dependent upon the academic program requested), with the expectation that these documents will reflect a high level of achievement, and that test scores will be current (less than five years from test date to anticipated school start date, if selected). Applicants are encouraged to devote significant study and preparation time before taking the GRE or GMAT.

Also, Air Force line officers should update their Airman Development Plan and apply to their appropriate Head Quarters, Air Force Personnel Center Assignment Team using AF IMT 3849 by the deadlines established for their career field and in accordance with instructions published by HQ/AFPC each year for their career field. Typically, HQ/AFPC announces AFIT Faculty Pipeline opportunities for the upcoming fiscal year in their annual Advanced Academic Degree (AAD) and Special Experience Exchange Duties (SPEED) Selection Process announcement normally posted on the AFPC web site in the spring of the year prior to the year of the fall school start for selectees. For more information about the annual AAD and SPEED announcements, contact your HQ/AFPC career field assignment officer. You can view the AFIT Graduate School Admissions Office web page for Air Force Officers applicants at http://www.afit.edu/ADMISSIONS/page.cfm?page=467&tabname=Tab3A.
APPENDIX G: COURSE DESCRIPTIONS

G.1 LOGISTICS DIVISION

LOGM 520 – Managerial Economics

Basic microeconomic principles such as supply and demand, elasticity, short-run and long-run shifts in resource allocation, diminishing returns, economies of scale, and pricing are covered. There is a general introduction to economics and economic reasoning, including the applications of economic theory to the firm. Also covered are various tools of analysis helpful to decision makers, including demand, production, and cost estimation using regression analysis, forecasting, capital budgeting, and risk analysis. The nature of economic incentives concerning consumers, workers, and business are studied.

Credit Hours: 4
Pre/Co-requisites: None
Terms Offered: Winter

LOGM 525 – Statistics for Mobility Managers

This course is designed as an introductory statistics course for graduate students in the Masters of Mobility Operations program offered at the Air Mobility Warfare Center. As such, it is to be taught from a managerial, rather than a mathematical perspective. Basic statistical concepts will be taught, including probability, distributions, hypothesis testing, and problem solving. Statistical techniques to be covered include both descriptive and inferential statistics, such as frequency distributions, histograms, regression analysis, chi-square, ANOVA, and nonparametric analysis. Emphasis is on the selection and analysis of statistical output, rather than manual computation, through the utilization of the software that is integrated with the text material.

Note: This course is open only to students in the Operations Management program.

Credit Hours: 4
Pre/Co-requisites: None
Terms Offered: Summer (ASAM)

LOGM 542 – Management of Logistics Organizations

This is a survey course covering the behavior of individuals and groups as it pertains to logistics organizations and the Air Force. Topics include, but are not limited to, decision theory and biases, motivation, cognition, individual differences, teams, and culture.

Credit Hours: 4
Pre/Co-requisites: None
Terms Offered: Winter (In-residence), Summer (DL)

LOGM 545 – Introduction to Management and Organizations

This is a survey course covering the behavior of individuals and groups as it pertains to organizations and the Air Force. Topics include, but are not limited to, decision theory and
biases, motivation, cognition, individual differences, teams, and culture. This course is offered to IDE students.

**Credit Hours:** 3

**Pre/Co-requisites:** None

**Terms Offered:** Winter (ASAM)

**LOGM 565 - Strategic Sourcing**

This course provides an introduction to and an overview of the strategic sourcing process including topics such as supplier selection, supplier evaluation, negotiation, contract management, supplier development, e-procurement, buyer-supplier relationships, strategic cost management, and purchasing law and ethics.

**Credit Hours:** 4

**Pre/Co-requisites:** None

**Terms Offered:** Winter

**LOGM 567 – Lean Operations Management**

Creating, sustaining, and employing military capability is the purpose of military leadership and management. Operations management theory outlines how organizations perform the systematic direction and control of the processes that transform inputs into finished goods and services. In the past decades, the concept on leanness has emerged as a management philosophy that can facilitate increased productivity while simultaneously reducing costs and improving service to the customer/warfighter. This course presents basic operations management concepts as well as the lean principles with a focus on how lean changes traditional operations management.

**Credit Hours:** 4

**Pre/Co-requisites:** None

**Terms Offered:** As Needed

**LOGM 568 – Introduction to Supply Chain Management**

This class provides and introduction to and overview of supply chain management concepts and practices with an emphasis on the areas related to logistics (a sub-area of supply chain management). Supply chain management and its supporting activities of strategic planning, purchasing, operations management, and logistics represent one of the cornerstones of competitive strategy for most organizations, including the Department of Defense. This course introduces the concepts and tools that will enhance the student’s understanding of supply chain management and their ability to effectively manage various supply chain operations.

**Credit Hours:** 3

**Pre/Co-requisites:** none

**Terms Offered:** Spring (DL); Summer (ASAM)

**LOGM 569 - Maintenance and Production Management**

This course explores operations management functions as applied to an Air Force environment. The course familiarizes the student with a variety of operations management techniques which
are being applied in maintenance as well as a variety of other operations management settings. Course topics include productivity, facility layout, location, capacity planning, quality control, scheduling, project management, queuing theory, inventory management, forecasting, and current operations management innovations.

**Credit Hours:** 4  
**Pre/Co-requisites:** None  
**Terms Offered:** Fall (DL and In-residence)

**LOGM 570 - Principles of Inventory Management**

This course develops fundamental understanding of the design and operation of inventory management systems. Specifically, this course provides students with a broad survey of methods and issues concerning managing inventory systems such as (1) logistics pipeline with emphasis on the DoD, (2) demand data and forecasting methods, (3) consumable and reparable inventory models, (4) information theory, and (5) management implications.

**Credit Hours:** 4  
**Pre/Co-requisites:** None  
**Terms Offered:** Spring (DL and In-residence)

**LOGM 590 - Computer Simulation for Managers**

The course concentrates on the concept of designing a model, running experiments with that model, and analyzing the results. The course's main emphasis is on the proper use of simulation techniques to model systems and answer logistics questions. Course work focuses on the use of the computer to enhance the decision-making capabilities of the logistics manager. This course provides the student with a working knowledge of discrete-event computer simulation as a decision-making tool.

**Credit Hours:** 4  
**Pre/Co-requisites:** MATH 291, STAT 525, STAT 535/LOGM 590L  
**Terms Offered:** As needed

**LOGM 590 - Lab**

Lab to be taken in conjunction with LOGM-590

**Credit Hours:** 0  
**Terms Offered:** As Needed

**LOGM 601 - Principles and Methods of Research**

The course provides information on how to conduct an appropriate review of literature to identify gaps and opportunities surrounding the problem area, and to identify and evaluate approaches for data collection and analysis leading to valid inference about the topic into answerable research and investigation questions leading to a formal research proposal. The broadest scope of qualitative and quantitative research methods is discussed. Application of appropriate research designs and analysis tools are course outcomes.
Credit Hours: 4  
Pre/Co-requisites: None  
Terms Offered: Winter (In-Residence, DL); Summer (ASAM)

LOGM 612 – Maintenance and Sustainment

In this course, students will learn how to manage the sustainment of assets within a large enterprise. The topics covered will include (1) multi-echelon supply chain management, (2) service supply chain management, (3) operations at various levels of repair (e.g., depot, intermediate, and back shop), (4) repair network design and (5) special topics in sustainment. Students will also be exposed to topics such as game theory and performance based contracting/logistics.

Credit Hours: 4  
Pre/Co-requisites: None  
Terms Offered: Spring

LOGM 613 - Transportation Policy and Strategic Mobility

Focuses on a study of the complex national and defense transportation policy frameworks that guide the constant development of our transportation systems. Examines how transportation policy impacts, and is, in turn impacted by policies formulated to address other national issues. Particular emphasis is placed on the study of the effects of national policies on the defense transportation system. Policy analysis models are presented and discussed.

Credit Hours: 3  
Pre/Co-requisites: None  
Terms Offered: Spring (ASAM)

LOGM 617 - Transportation Systems and Strategic Mobility

Examines each transportation mode for similarities and differences. Ownership of the modes is also detailed, along with cost and service characteristics. Each mode is then examined for its particular contribution to the defense transportation system. The mission, organization, resources and financing arrangements of the three transportation operation agencies of the defense transportation system are examined. Problems associated with strategic mobility are emphasized.

Credit Hours: 4  
Pre/Co-requisites: None  
Terms Offered: Fall (In-Residence)

LOGM 619 - Transportation Policy and Strategic Mobility

Focuses on a study of the complex national and defense transportation policy frameworks that guide the constant development of our transportation systems. Examines how transportation policy impacts, and is, in turn impacted by policies formulated to address other national issues. Particular emphasis is placed on the study of the effects of national policies on the defense transportation system. Policy analysis models are presented and discussed.

Credit Hours: 4
LOGM 620 - Activity Based Costing/Management

The course is designed to give the students knowledge of Activity Based Costing (ABC), why traditional accounting practices do not support managerial decision-making, and techniques to perform ABC. Activity Based Management will be introduced to enable the student to utilize the output from ABC. The development and application of non-financial metrics will be covered. Students will be introduced to the Theory of Constraints, and Balanced Scorecard will be covered. Examples from DoD and the commercial sector will be used to illustrate the application of ABC.

Credit Hours: 4
Pre/Co-requisites: None
Terms Offered: Summer (In-residence)

LOGM 621 - Air Transportation Management

This course focuses on the air operations/air management aspect of the transportation network. As such, the students are expected to develop an understanding of both civilian and military air cargo and air passenger network operations. Topics covered will include: Airline/Air Cargo forecasting and management, principles of air scheduling, and the interaction between the civilian and military air transportation systems. Similarities and differences between these two systems will be covered extensively. The reliance of the DoD on civilian air transportation will be emphasized.

Credit Hours: 3
Pre-requisite: None
Terms Offered: Winter (ASAM)

LOGM 622 - Transportation Systems and Strategic Mobility

Examines each transportation mode for similarities and differences. Ownership of the modes is also detailed, along with cost and service characteristics. Each mode is then examined for its particular contribution to the defense transportation system. The mission, organization, resources and financing arrangements of the three transportation operation agencies of the defense transportation system are examined. Problems associated with strategic mobility are emphasized.

Credit Hours: 3
Pre/Co-requisites: None
Terms Offered: Fall or Winter (ASAM)

LOGM 626 – Supply Chain Management Capstone

This is a program capstone course that concentrates on the relationship of key business processes within the firm and across the network of firms that comprise the supply chain, in any organization. Key emphasis is on the senior leader and manager perspective of managing a complex organization and supply chain, developing various leadership strategies to execute the
objective, being able to map key supplier/customer relationships, and ensuring personnel develop and utilize proper metrics to gauge performance of the organization. A capstone project and case study culminate the learning.

Credit Hours: 3
Pre/Co-requisites: None
Terms Offered: Spring (ASAM)

LOGM 627 - Supply Chain Management

This course concentrates on the cross-functional integration of key business processes within the firm and across the network of firms that comprise the supply chain in both commercial and DoD organizations. Emphasis is on managing the complexity of the supply chain, developing supply chain strategies, selecting metrics, and mapping supply chain networks. The concept of business partnerships will also be explored. A capstone project provides students with hands-on experience in managing the integration of functional skills such as planning, forecasting, inventory management, and distribution.

Credit Hours: 4
Pre/Co-requisites: None
Terms Offered: As needed

LOGM 630 - Forecasting Management

Since the DoD community collects much of its data as a natural time series, this course is concerned with the application of time series analysis theory in describing and forecasting logistics performance. This course covers analysis of time series data patterns, introduction of major forecasting techniques, measuring the effectiveness of these techniques, and implementing time series analysis theory in describing and forecasting logistics performance. Statistical development will be brief with intent to survey a wide variety of concepts. Forecasting methods covered include: moving average, exponential smoothing, regression, econometric, and Box-Jenkins.

Credit Hours: 4
Pre-requisites: STAT 525, STAT 535
Terms Offered: Spring

LOGM 631 - Scheduling: Theory and Application

This course is an introduction to scheduling theory with applications in manufacturing and services. The course is of primary interest to officers in the maintenance career field who often encounter production scheduling problems in an industrial setting as well as workforce scheduling problems. Manufacturing applications include machine scheduling, job shop scheduling, scheduling of flexible assembly systems, and planning and scheduling supply chains. Services applications include reservations and timetabling, tournament scheduling, planning and scheduling in transportation, and workforce scheduling. The course is quantitative in nature but will also address management implications.

Credit Hours: 4
Pre-requisites: MATH 291, STAT 525, and STAT 535  
Terms Offered: Fall

LOGM 634 - Reliability, Maintainability, and Supportability

Creating and sustaining military capability is the purpose of military leadership and management. Reliability and maintainability (R&M) are component characteristics which define the ability of a product to perform its specified functions throughout its operational life. Component R&M of the military system are primary determinants of military capability. This course teaches fundamental R&M and product warranty concepts. Additionally, probability theory is discussed and employed as a tool to quantitatively define these concepts. Topics discussed include the measures which quantitatively define component R&M, the relationships between reliability, maintainability, and availability, and the prediction of R&M measures.

Credit Hours: 4

Pre-requisites: Resident Students: STAT 525, STAT 535 or equivalents.
Terms Offered: Spring (as needed)

LOGM 636 - Service Operations Management

The body of knowledge pertaining to the management of operations has evolved largely in the context of manufacturing. However, the majority of operations in both the commercial and defense sectors are more properly classified as services, whose outputs are less tangible. This course draws on production management techniques to enhance the effectiveness of managers of service operations. Topics covered include characteristics of services, establishing customer service levels, designing service delivery systems, measuring systems performance, the psychology of waiting lines, and scheduling personnel and capacity.

Credit Hours: 3

Pre-requisites: LOGM 568
Terms Offered: Winter (ASAM)

LOGM 639 - Reliability, Maintainability, and Supportability

Creating and sustaining military capability is the purpose of military leadership and management. Reliability and maintainability (R&M) are component characteristics which define the ability of a product to perform its specified functions throughout its operational life. Component R&M of the military system are primary determinants of military capability. This course teaches fundamental R&M and product warranty concepts. Additionally, probability theory is discussed and employed as a tool to quantitatively define these concepts. Topics discussed include the measures which quantitatively define component R&M, the relationships between reliability, maintainability, and availability, and the prediction of R&M measures.

Credit Hours: 3

Pre-requisites: Ft. Dix Students: LOGM 525
Terms Offered: As needed (ASAM)
LOGM 644 – Current Topics in Logistics

This course is a seminar-based investigation into current and emerging topics which originate in, or affect, logistics thought or action. The purpose of this course is to provide knowledge depth to students on critical issues most likely to affect the logistics field in the coming years. The main source of these issues will be recent academic and trade publications. Following individual, in-depth critiques of these works, class members will discuss topics in an open discussion format. Students will be challenged to take and defend their positions on a variety of issues relevant to the field of logistics. A final project will allow each student to more deeply explore an area of special interest within the field of logistics.

**Credit Hours:** 4  
**Pre/Co-requisites:** None  
**Terms Offered:** Summer

LOGM 650 - Seminar in Space Logistics

This course will address, in a seminar format, the activities associated with supporting all aspects of military and civilian space operations. Topics to be covered include: logistical support for spacecraft, satellites, stations, facilities, or other entities on earth orbits or on orbits/trajectories associated with or situated on other celestial bodies. Discussion will address planning for total life cycle support, continued support of operation and maintenance, and current issues in space logistics operations and support.

**Credit Hours:** 4  
**Pre/Co-requisites:** None  
**Terms Offered:** Fall (As needed)

LOGM 651 – Seminar in Petroleum Management

This course will provide an overview of the primary aspects of petroleum management within the Department of Defense. Major topics to be covered include: product procurement, transportation modal selection, storage and inventory management, quality assurance, distribution, and joint operations. Additional areas include alternative fuels, environmental concerns, and interfaces with key Department of Defense organizations.

**Credit Hours:** 4  
**Pre/Co-requisites:** None  
**Terms Offered:** Fall

LOGM 660 - Strategy for Logistics

This course focuses on the strategy process and its specific application to the logistics discipline. It covers the strategy formulation, implementation, and evaluation process at the enterprise level to include discussions of the top level decisions and their long-term impact on the organization. The course will apply those concepts to the major decision factors involving infrastructure and organizational issues in logistics enterprises and business units.

**Credit Hours:** 4  
**Pre/Co-requisites:** None  
**Terms Offered:** Fall (As-needed)
LOGM 675 - Logistics Management Colloquium
This course introduces students to current issues, concerns, and practices of logistics management through a series of presentations by key logistics personnel during the graduate program.
Credit Hours: 0
Pre/Co-requisites: None
Terms Offered: All

LOGM 682 – Business Analytics II
Business analytics is an approach to analyze data using statistics, quantitative methods, and information technology and develop mathematical or computer-based models to help managers for their data-driven decision making or actions with insights obtained from the analysis of data. This course emphasizes advanced topics in data visualization, regression analysis including econometrics, and linear programming and its extension (i.e., data envelopment analysis) for distilling actionable insights from data. Students will work on applied research projects to gain hands-on experience.
Credit Hours: 4
Pre/Co-requisites: None
Terms Offered: Summer

LOGM 699 – Master’s Level Special Studies
Special topics of study for master’s student in Logistics and Supply Chain Management under the direction of a member of the Logistics faculty.
Credit Hours: 1-12
Requisite: Approval of Instructor
Terms Offered: All

LOGM 701 – Advanced Research Methods
This advanced research methods course provides a PhD-level introduction to academic research and theory with a specific focus on concepts necessary to properly write and defend a research proposal.
Credit Hours: 4
Requisite: Approval of Professor
Terms Offered: Winter

LOGM 768 – Advanced Topics in Logistics
This course is intended for students planning advanced study and research in the areas of logistics and supply chain management. A continuation of material covered in LOGM 627, the course covers in more detail the theoretical properties of product support and physical
distribution systems found in defense and commercial sector contexts. Course topics are drawn from the current literature.

**Credit Hours:** 3  
**Pre-requisite:** LOGM 627  
**Terms Offered:** Fall

**LOGM 770 – Advanced Inventory Theory**

This course develops advanced concepts in the design and operation of inventory management systems. Specifically, this course will examine various research methods to study advanced inventory theories. Students will investigate inventory theoretic issues such as demand data, forecasting of inventory requirements, dependent and independent inventory modeling, and select topics as determined by the professor. The emphasis is on both analytic development and data analysis.

**Credit Hours:** 3  
**Pre-requisite:** LOGM 570  
**Terms Offered:** Fall

**LOGM 791 - Research Project for Operations Managers**

A research topic is selected from mobility problems of interest to USAF and DoD. This topic is thoroughly investigated by the student, and the findings, recommendations, and conclusions are presented as a graduate research paper under the supervision of an AFIT faculty member.

**Credit Hours:** 1-8  
**Pre/Co-requisites:** None  
**Terms Offered:** All

**LOGM 799 – Thesis Research**

A research topic is selected from those problems of interest to USAF and DoD. The topic is thoroughly investigated by the student and the findings, recommendations, and conclusions are presented in a formal thesis under the supervision of a departmental professor.

**Credit Hours:** 1-12  
**Pre/Co-requisites:** None  
**Terms Offered:** All

**LOGM 899 – Doctoral Level Special Studies**

Special topics of study for doctoral students in Logistics under the direction of the Logistics faculty.

**Credit Hours:** 1-12  
**Requisite:** Approval of Instructor  
**Terms Offered:** All
LOGM 999 – Dissertation Research

Dissertation research conducted in Logistics: including, but not limited to, selection of research advisor and topic, formation of research committee, supervision of the research, presentation and defense of the dissertation in accordance with Doctoral Council policy letters.

Credit Hours: 1-12
Pre/Co-requisites: None
Terms Offered: All

PENS 791 – Research Project Completion

Project completion course. Credit given for completion of research project.

Credit Hours: 7
Pre/Co-requisites: None
Terms Offered: All
G.2 OPERATIONS RESEARCH DIVISION

OPER 498 - Research Methods
This course is designed to provide the student with an understanding of the research process and department research expectations. Topics include problem definition, use of secondary sources, research design, and communication of results. Students prepare and present a research proposal.
Credit Hours: 1
Pre/Corequisites: None
Terms Offered: Spring

OPER 500 - Operational Sciences Seminar
This seminar acquaints students with the application of operations research to Air Force and DoD issues and with faculty research interests. This course also provides a forum for lectures by distinguished visitors.
Credit Hours: 0
Pre/Co-requisites: None
Terms Offered: Fall; Winter; Summer

OPER 501 - Quantitative Decision Making
This is an introductory course in management science applications for the logistics, systems, acquisition, and transportation manager. Emphasis is on understanding and applying the techniques to managerial problem solving and decision making. Major topics include linear programming, decision theory, networks, and queuing theory.
Credit Hours: 3
Co-requisite: OPER 501L
Terms Offered: Fall (ASAM)

OPER 501L - Quantitative Decision Making Lab
Lab associated with OPER-501
Credit Hours: 0
Co-requisite: OPER 501
Terms Offered: Fall (ASAM)

OPER 505 – Business Analytics I
This is an introductory course in operations research/management science. Major topics include Linear Optimization, Descriptive Data Mining, Linear Regression, Monte Carlo Simulation, and Decision Analysis. Emphasis is on understanding and applying the techniques to managerial problem solving and decision making. Students will be expected to demonstrate their ability to identify applications, formulate appropriate models, and obtain and interpret analytical results. Microsoft Excel with add-in utilities is the primary analytical tool.
Credit Hours: 4  
Co-requisite: OPER 505L  
Terms Offered: Fall

**OPER 505L – Business Analytics Lab**

Lab associated with OPER-505  
Credit Hours: 0  
Co-requisite: OPER 505  
Terms Offered: Fall

**OPER 510 – Introduction to Mathematical Programming**

In this breadth-oriented course, students learn the art and science of formulating mathematical programs and are exposed to classical problems in linear programming, nonlinear programming, integer programming, and dynamic programming. Selected solution methods and their theoretical underpinnings for each realm are introduced and motivated, as well as the use of commercial solvers and interpretation of results. Concepts such as duality and optimality conditions will be given a limited treatment, primarily to understand how to better utilize and tailor settings for commercial software.  
Credit Hours: 4  
Pre-requisites: MATH 523 or Approval of Instructor  
Terms Offered: Fall

**OPER 540 - Stochastic Modeling and Analysis I**

This course applies the fundamental probability theory to develop standard approaches to stochastic modeling in operations research. Specific topics include conditional probability and expectation, the Poisson process and exponential distribution, discrete-time Markov chains, and continuous-time Markov chains. The various models are discussed in the context of military applications.  
Credit Hours: 4  
Pre-requisites: STAT 583 or STAT 587 or Approval of Instructor  
Terms Offered: Winter

**OPER 542 - Decision Analysis using VFT**

This course presents a logical, systematic procedure for applying Multiobjective Decision Analysis (MODA) to complex, real world decision problems. Emphasis is placed evenly across the socio-technical process to applying value focused thinking to create value for decision makers facing difficult decisions. Topics to be covered include: identifying & structuring objectives, selecting appropriate attributes to measure achievement of objectives, developing value functions that accurately reflect decision-maker preference structures, and analysis techniques for obtaining insight from the developed model. Techniques for applying Decision Analysis in practice are introduced.  
Credit Hours: 4
Pre-requisites: STAT 583 or STAT 587 or Approval of Instructor
Terms Offered: Winter

OPER 544 – Operational Decision Support Systems
This course blends techniques from the fields of operations research, management sciences, artificial intelligence, and information systems to create decision support systems primarily using Excel, including Excel VBA and specialized add-ins for analysis. This course will integrate the use of spreadsheets with operations research topics such as decision analysis, Monte-Carlo simulation, and optimization models.

Note: OPER 544 (lecture) is a 2 credit hour course. OPER 544L is a 1 credit hour course (three contact hours.) Students registering in OPER 544 will automatically be registered in OPER 544L. Upon completion, two grades will be received, one for OPER 544 and one for OPER 544L.

Credit Hours: 2
Pre-requisites: OPER 542, OPER 561, and OPER 610 or Approval of Instructor.
Co-requisite: OPER 544L
Terms Offered: Summer

OPER 544L Operational Decision Support Systems Lab
This course is a 1 credit lab taught in conjunction with OPER 544 Lecture.

Credit Hours: 1
Co-requisite: OPER 544
Terms Offered: Summer

OPER 561 - Discrete-Event Simulation
This is an introductory course on the use of computer simulation modeling to analyze complex military systems. The focus of the course is on the development of discrete-event simulation models and the analysis of simulation model input and output. A modern simulation language is taught to provide a modeling framework and the means for implementing a computerized model. Basic concepts important to simulation studies such as random number and random variate generation, model verification and validation, and output analysis are discussed. Examples are oriented toward DoD operational systems.

Credit Hours: 4
Pre-requisites: STAT 583 and STAT 587 or Approval of Instructor
Terms Offered: Spring

OPER 601 - Operations Research Seminar
This course is designed to provide students, primarily those enrolled in the doctoral program, with information relating to the state-of-the-art within the Operations Research field. Prominent speakers in the field will be invited and used whenever possible. This course may also be used by the faculty to present recent developments in their research and by doctoral candidates to present progress reports on their dissertation research.
OPER 610 - Linear Programming

In this depth-oriented course, students learn the theoretical concepts that motivate and enable key exterior and interior solution methods for linear programming as a basis for future studies. While refining mathematical programming skills, they learn to implement these solution methods with emphasis on key concepts: identifying an initial feasible solution, iterating to assure a convergent sequence of improving feasible solutions, and identifying an optimal or epsilon-optimal solution. Selected methods are enhanced by a rigorous understanding and application of duality theory.

Credit Hours: 3
Pre-requisites: OPER 510 and MATH 523 or Approval of Instructor
Terms Offered: Winter

OPER 612 - Nonlinear Programming

This course is a detailed study of nonlinear programming techniques. The differential calculus and Karush-Kuhn-Tucker results for constrained optimization are presented, including convexity, local and global optima, and saddle point conditions. A thorough treatment of duality theory and Lagrangian duality constitutes a major portion of the course, and serves to unify several key points. Various classes and types of techniques for solving nonlinear programs are presented, including geometric programming. Modern derivative-free optimization methods are also introduced.

Credit Hours: 3
Pre-requisites: OPER 610 or Approval of Instructor
Terms Offered: Fall

OPER 613 - Integer Programming

Integer programming is the class of mathematical programming models that requires some or all of the variables to assume discrete or integer values. This course covers modeling, theoretical developments, and the principal solution procedures associated with the subject. At the completion of the course, the student should be able to recognize when integer programming is appropriate, set up a model for solution by an available algorithm, solve the model, interpret the solution, and understand the theoretical basis for the solution procedure.

Credit Hours: 3
Pre-requisites: OPER 510 or Approval of Instructor
Terms Offered: Fall

OPER 614 - Dynamic Programming

This course addresses the theory and practice of dynamic programming, i.e., optimal sequential decision making over time. The course will stress intuition, the mathematical foundations being for the most part elementary. Applications will be considered in capital investment,
transportation, and production and inventory control.

**Credit Hours:** 3  
**Pre-requisites:** OPER 510 and OPER 504 or OPER 540, or Approval of Instructor  
**Terms Offered:** Fall

**OPER 615 - Large Scale Systems Optimization**

Large scale systems optimization takes advantage of the structure of large problems to develop efficient algorithms for their solution. Many large problems can only be solved by taking advantage of these special structures. The course examines the relationship between special structures and the algorithms which take advantage of them. Topics include interior point methods, Dantzig-Wolfe decomposition, column generation, Bender’s decomposition, generalized upper bounding, and Lagrangian relaxation. Several examples of large problems will be examined, including scheduling a delivery fleet.

**Credit Hours:** 3  
**Pre-requisites:** OPER 610 or Approval of Instructor  
**Terms Offered:** Winter

**OPER 617 - Networks**

This course is an introduction into the study of networks. Topics include basic graph terminology, formulation of problems involving graphs, maximum flow, shortest path, minimum cost flow, minimum spanning tree, and network design. The algorithms and their corresponding computational complexity are discussed, motivated by a wide variety of applications including routing and inventory management.

**Credit Hours:** 3  
**Pre-requisites:** OPER 510 or Approval of Instructor  
**Terms Offered:** Summer

**OPER 621 – Multicriteria Optimization**

This course exposes students to a variety of solution methods for multicriteria optimization problems with an emphasis on theory and applications. Topics covered include efficient points, goal programming, weighted sum and scalarization techniques, multiobjective linear programming, multiobjective combinatorial optimization, and multiobjective versions of well-known easy and hard optimization problems.

**Credit Hours:** 3  
**Pre-requisites:** OPER 501 or OPER 510, or Approval of Instructor  
**Terms Offered:** As Needed

**OPER 623 - Heuristic Search Methods**

Introduction and application of modern search methods for solving complex optimization problems. Topics include genetic algorithms, simulated annealing, tabu search, hybrid combinations, and adaptive techniques.

**Credit Hours:** 3
Pre-requisites: OPER 501 or OPER 510, or Approval of Instructor
Terms Offered: Spring

OPER 626 - Scheduling Theory

The course covers the theory and solution methods for scheduling several tasks over time. Topics include terminology, measures of performance, single machine sequencing, flowshop scheduling, the job shop problem and priority dispatching. Side constraints within scheduling, such as precedence, release dates, and due dates are addressed.
Credit Hours: 3
Pre-requisites: OPER 510 or Approval of Instructor
Terms Offered: Winter

OPER 638 – Assessing Operational Cost and Risk

This course develops the theory of operational cost analysis, the evaluation of operational risk, and game theory. The effects of time on economic and monetary evaluation are studied, and risk and its impact on decision making is investigated. Specific topics covered include cost estimation, economic evaluation, risk assessment, value and utility functions, and multi-attribute utility theory. A system analysis perspective is used in the presentation of course material.
Credit Hours: 3
Pre-requisites: OPER 510, OPER 540, OPER 542, and STAT 587, or Approval of Instructor
Terms Offered: Fall

OPER 641 - Stochastic Modeling and Analysis II

This course develops advanced concepts in the modeling and analysis of complex stochastic systems. Specific topics include generalizations of the Poisson process, renewal theory, regenerative processes, Markov-renewal theory, and Markov-regenerative processes. The course also introduces martingale, Brownian motion, and other diffusion processes.
Credit Hours: 3
Pre-requisites: OPER 540 or Approval of Instructor
Terms Offered: Spring

OPER 642 – Decision Analysis under Uncertainty and Risk

This course builds upon the Multiobjective Decision Model (MODA) by including uncertainty and risk into the problem formulation. Emphasis is placed evenly across the socio-technical process to create value for decision makers facing difficult decisions. Topics covered include: structuring a decision problem w/decision trees & decision diagrams, treating uncertainty using probability as a measure of belief, treating risk attitude using von Neumann-Morgenstern expected utility theory, applying Monte Carlo simulation to uncertainty, and examining the value of information. Particular emphasis is placed on understanding the relationship between preference statements, value functions, and value trade-offs.
OPER 645 - Risk Modeling and Analysis

This is a course on the theory and practice of risk analysis. Specific topics include quantitative risk assessment, multi-objective risk assessment, multi-objective risk analysis, Bayesian networks, game theory, actuarial risk, and fault tree analysis. Military and industrial applications are discussed.

Credit Hours: 3
Pre-requisites: OPER 542 and STAT 583 or STAT 587 or Approval of Instructor
Terms Offered: Spring

OPER 647 - Queueing System Analysis

This course begins with an overview of stochastic modeling and transforms methods. These techniques are then employed in equilibrium analysis of simple Markov and embedded Markov queueing systems. Results are extended to address more advanced modeling concepts such as priority customers, bulk arrivals or service, generalized distributions of interarrival or service times, and networks of queues. Potential applications are discussed, including performance evaluation and optimization of communication systems, transportation networks, computer systems, and other resource-constrained operations.

Credit Hours: 4
Pre-requisites: OPER 540 or Approval of Instructor
Terms Offered: Summer

OPER 655 – Text Mining

Text mining is the organization, classification, labeling and extraction of information from text sources. In these days of more information readily available through the Internet, analysts and decision makers find themselves overloaded with data. Text mining is an application which can help analysts glean necessary information either for general understanding about a corpus of text documents, or for putting text into a form useful for the application of alternative analysis techniques. This course will introduce students to this rapidly growing field and equip them with some of its basic principles and tools as well as its general mindset. Students will learn concepts, techniques and tools they need to deal with text mining practice in a Joint military context.

Credit Hours: 3
Pre-requisites: OPER 679 and OPER 685
Terms Offered: Fall

OPER 661 - Statistical Aspects of Simulation: Output Analysis

This course provides an in-depth treatment of a number of important issues in the Statistical Aspects of Simulation. The emphasis in this course is on output modeling. Topics include the analysis of terminating and steady state simulation output as well as variance reduction
techniques. It is intended to provide a rigorous treatment of current issues within the simulation literature.

**Credit Hours:** 3  
**Pre-requisites:** OPER 561 or Approval of Instructor  
**Terms Offered:** Fall

**OPER 671 - Combat Modeling**

The purpose of this course is to expose students to combat modeling by examining air operations from an application oriented point of view to include mission planning. Basic combat processes are discussed along with general methods for how they are modeled to include aggregated approaches such as Lanchester equations. The Advanced Framework for Simulation, Integration, and Modeling (AFISM) is introduced and used to develop and modify scenarios for analysis as part of the course requirements.

**Credit Hours:** 4  
**Restricted:** U.S. Citizens Only  
**Pre-requisites:** OPER 561 or Approval of Instructor  
**Terms Offered:** Summer

**OPER 674 - Joint Mobility Modeling**

The purpose of this course is to present mobility modeling from an application oriented large-scale point of view. Models currently in use for DoD analysis are examined. Particular attention will be given to the air mobility problem and its relation to land and sea mobility. Both strategic and theater mobility issues are explored.

**Credit Hours:** 3  
**Pre/Co-requisites:** None  
**Terms Offered:** Fall (Ft Dix Only); Winter

**OPER 676 - Information Operations Research**

This course is designed to increase the awareness and integration of the relationship between Information Operations (IO) and Operations Research. The focus will be on the tools, techniques, theories, and models currently in use for IO analysis. Particular attention will be paid to current IO modeling issues.

**Credit Hours:** 3  
**Restricted:** U.S. Military Only  
**Pre/Co-requisites:** None  
**Terms Offered:** Summer

**OPER 679 - Empirical Modeling**

Analysis of experimental and observational data from engineering systems. Focus on empirical model building using observation data for characterization, estimation, inference and prediction.

**Credit Hours:** 3  
**Pre-requisites:** STAT 583 or STAT 587, or Approval of Instructor  
**Terms Offered:** Spring (DL and In-residence)
OPER 681 - Statistical Process Control

This course provides an in-depth treatment of the fundamental concepts and methods of modern statistical process control. The primary focus will be on the use of control charts for monitoring the process mean and variance. Other topics include process capability analysis, the modern role of acceptance sampling, and the use of such statistical techniques within the context of total quality management.

Credit Hours: 3
Pre-requisites: STAT 583 or STAT 587, or Approval of Instructor
Terms Offered: As Needed

OPER 683 - Response Surface Methodology

This is a course on advanced experimental design. Topics include process improvement with steepest ascent, design optimality criteria, designs for fitting response surfaces, analysis of nonlinear response functions, and designs subject to randomization restrictions. State-of-the-art experimental design and analysis methods are included as special topics.

Credit Hours: 3
Pre-requisites: OPER 679 or STAT 696 and OPER 688 or Approval of Instructor
Terms Offered: Fall

OPER 684 - Quantitative Forecasting Techniques

This is a course in applied techniques to predict discrete time-series phenomena. The emphasis is on understanding and applying forecasting tools in analysis and management settings. Both classical smoothing methods and the Box-Jenkins methodology for model identification, estimation, and prediction are presented. Time series data are modeled and predictions made with interactive computer software.

Credit Hours: 3
Pre-requisites: STAT 583 or STAT 587, or Approval of Instructor
Terms Offered: Winter (Cross-listed with LOGM 630)

OPER 685 - Applied Multivariate Analysis I

This course is oriented toward the computer-assisted analysis of multidimensional data. The course will present statistical techniques such as multiple regression, principal components analysis, canonical correlation, factor analysis, cluster analysis, discriminate analysis and neural networks. Emphasis will be on practical application to data sets using computerized statistical packages.

Credit Hours: 3
Pre-requisites: STAT 587 or Approval of Instructor
Terms Offered: Spring

OPER 688 - Operational Experimentation

Introduction to designing experiments for operational testing and evaluation. This is an applied course intended for operations analysts who perform experiments or serve as advisors to
experimentation. A statistical approach to the design and analysis of experiments is provided as a means to efficiently study and comprehend the underlying process or system being evaluated. Insight gained leads to improved system performance and quality.

**Credit Hours:** 3  
**Pre-requisites:** OPER 679 or STAT 696 or Approval of Instructor  
**Terms Offered:** Summer (DL and In-residence)

**OPER 689 – Advanced Statistical Methods for Test**

This course builds upon the material in the prerequisite course providing advanced coverage in time series modeling, generalized linear models, and advanced experimental design. Examples and projects are focused on problems from the test and evaluation enterprise.

**Credit Hours:** 3  
**Pre-requisites:** OPER 679 and OPER 688  
**Terms Offered:** Winter (DL)

**OPER 695 - Issues in Defense Analysis**

This course discusses the role of analyses in defense, national and international security decisions. The course focuses on the analyst's role in providing structure to complex issues and developing analytically-sound insights to support defense leaders. Specific topics include determining decisions' values, timeliness, measures of merit, modeling resolution, technique selection, data availability, accuracy, gaining insights, and communicating analytic results. Students examine historical and contemporary case studies to demonstrate the contributions and limitations of analysis in the decision-making process. Additional topics include analytical pitfalls, along with issues of bias, advocacy, and ethics in defense analysis.

**Credit Hours:** 3  
**Pre/Co-requisites:** None  
**Terms Offered:** Winter

**OPER 699 – Master’s Level Special Study**

Directed study at an intermediate graduate level on a special topic which is not normally covered in a regularly scheduled course or as part of thesis research. Topic, format, and requirements of the course are determined by the faculty member directing the study. Requires submission of Special Studies Form and syllabus to the department for registration.

**Credit Hours:** 1-12  
**Requisite:** Approval of Instructor  
**Terms Offered:** All

**OPER 710 - Advanced Linear Programming and Extensions**

This course will explore the theoretical properties of the general linear program (LP), developing results concerning extreme points, the existence of extreme point solutions, interior point methods for LP, computational complexity, fractional programming, and current developments in LP.
Credit Hours: 3
Pre-requisite: OPER 610
Terms Offered: As Needed

OPER 712 - Advanced Math Programming

This course is intended for students planning advanced study and research in the areas of mathematical programming and optimization. A continuation of material covered in OPER 612, the course covers in more detail the theoretical and topological properties of the general nonlinear programming problem. Other topics are drawn from the current literature.
Credit Hours: 3
Pre-requisite: OPER 612
Terms Offered: As Needed

OPER 713 - Advanced Integer Programming

Integer programming is the class of mathematical programming models that requires some or all of the variables to assume discrete or integer values. This course covers advanced modeling and theoretical developments. The course will focus on polyhedral theory, computational complexity, integer lattices, valid inequalities, and Lagrangian relaxation.
Credit Hours: 3
Pre-requisite: OPER 613
Terms Offered: As Needed

OPER 743 - Decision Analysis Practice

This course examines the professional practice of decision and risk analysis. The course provides new material on the selection of decision analysis topics, the interface with the decision makers and technical experts, the advanced use of decision analysis software, and the presentation of results to decision makers. Students have the opportunity to apply their knowledge and risk analysis to a real decision for a real decision maker.
Credit Hours: 3
Pre-requisites: At least two of the following courses: OPER 542, OPER 621, OPER 642, OPER 645, or Approval of Instructor
Terms Offered: Winter

OPER 746 - Advanced Topics in Reliability

This course develops advanced mathematical concepts for application in the reliability and maintainability areas. Topics include censored reliability data analysis, optimal preventive maintenance policies, warranty analysis, burn-in strategies, and other topics of current interest. The emphasis is on both analytic development as well as actual application to data analysis. The course will consider the implications of reliability during the system design phase as well as the system operational phase. Simulation software as well as “solver” software will be utilized in class exercises.
Credit Hours: 3
Pre-requisite: OPER 540
Terms Offered: As Needed

OPER 785 - Applied Multivariate Analysis II: Pattern Recognition
This course is a survey course in pattern recognition. Theory, parameters estimation, linear discriminate functions, multilayer neural networks, and other topics. Real-world applications will be emphasized.
Credit Hours: 3
Pre-requisites: OPER 685 or Approval of Instructor
Terms Offered: As Needed

OPER 786 - Multivariate Analysis III: Advanced Topics
This course examines a variety of topics in pattern recognition such as Bayesian networks, hidden Markov models, neural feature selection procedures, and sensor fusion. Recent research in these areas is explored.
Credit Hours: 3
Pre-requisites: OPER 785 or Approval of Instructor
Terms Offered: As Needed

OPER 791 - Research Project for Operational Sciences
A research topic is selected from problems of interest to USAF and DoD. This topic is thoroughly investigated by the student, and the findings, recommendations, and conclusions are presented as a graduate research paper under the supervision of an AFIT faculty member.

Note: Available only for students enrolled in the Test and Evaluation Certificate Program (TECP) or the Intermediate Developmental Education (IDE) Program. This course is offered as the 3 credit hour capstone course (distance learning) for TECP students. It may also be taken in residence for 6-7 credit hours by IDE students.
Credit Hours: 6-7
Pre/Co-requisites: None
Terms Offered: All

OPER 799 - Thesis Research
A research topic is selected from those problems of interest to USAF and DoD. The topic is thoroughly investigated by the student and the findings, recommendations, and conclusions are presented as a formal thesis under the supervision of a departmental professor. On site research is conducted as required. An oral presentation and defense of research work results are required.
Credit Hours: 1-12
Pre/Co-requisites: None
Terms Offered: All
OPER 899 – Doctoral Level Special Studies
Credit Hours: 1-12
Requisite: Approval of Instructor
Terms Offered: All

OPER 999 - Dissertation Research
Dissertation research conducted in Operations Research; including, but not limited to, selection of a research advisor and topic, formation of the research committee, supervision of the research, presentation and defense of the dissertation in accordance with Doctoral Council policy letters.
Credit Hours: 1-12
Pre/Co-requisites: None
Terms Offered: All

TENS 799 – Thesis Completion
Thesis completion course for graduating students to be taken during the last quarter of study. Registration in TENS 799 for 12 non-billable credit hours is required for all master’s students whose research advisors are in the Department of Operational Sciences. The grade assigned to this course is the official thesis grade.
Credit Hours: 12
Pre/Co-requisites: None
Terms Offered: All
APPENDIX H: PEOS AND POS

The Department of Operational Sciences has identified specific Program Educational Objectives (PEOs) which are statements that describe student expectations two or more years beyond graduation for each of our masters programs. The Department has also identified specific Program Outcomes (POs) which are statements that describe what students should know or be able to perform (knowledge/skills/abilities) upon completion of their masters or doctoral degree or certificate program. PEOs and POs specific to each program were incorporated into each program description discussed in chapters 4, 5 and 6. These PEOs and POs are cited in a consolidated format in this appendix.
<table>
<thead>
<tr>
<th>PROGRAM (COLLEAGUE NAME)</th>
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<th>Program Outcomes (POs) (Knowledge/Skills/Abilities Upon Graduation)</th>
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<td>OR.PHD</td>
<td>IAW ENOI 36-117, para 3.3, dated 27 Feb 2012, PEO definition, development, and publication are not required for Ph.D programs.</td>
<td>1. The graduates will be able to understand and evaluate critically the literature of the field.</td>
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<td>2. The graduates will be able to apply appropriate principles and procedures to the recognition, evaluation, interpretation, and understanding of issues and problems at the frontiers of knowledge.</td>
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<td>3. The graduates will have acquired the knowledge, skills, ethics, and independence of thought and action expected of a scholar.</td>
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<td>4. The graduates will have extended and effectively communicated knowledge in his or her field.</td>
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<td>LSCMGTPH.D</td>
<td>IAW ENOI 36-117, para 3.3, dated 27 Feb 2012, PEO definition, development, and publication are not required for Ph.D programs.</td>
<td>1. The graduates will be able to understand and evaluate critically the literature of the field.</td>
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| OR.MS                   | Our Program Educational Objectives are to provide graduates who:  
1. **Breadth.** Apply foundational operational research analysis techniques to efficiently and effectively advance Air Force, DoD, and other government inter-agency organizations, as well as other employer capabilities.  
2. **Depth.** Are well educated, highly-valued, and successful operation research analysts.  
3. **Professionalism.** Professionally communicate technical analytical assessments, solutions, and results.  
4. **Lifelong Learning.** Continue to pursue lifelong multidisciplinary learning. | 1. **Critical thinking and problem solving skills.** Have the ability to classify, formulate, and solve operations research problems.  
2. **Operations research specific knowledge.** Have knowledge of operations research areas such as probabilistic modeling, applied statistics, mathematical programming, simulation, and decision analysis to directly support decision and policy making activities.  
3. **Communication skills.** Develop written and oral communications skills necessary to present complex problems to a decision-making audience: problem definition, modeling methodologies, including solution advocacy that utilizes rigorous analytical support. |
| LSCMGT.MS               | Our Program Educational Objectives are to provide graduates who:  
1. **Breadth.** Apply foundational logistics concepts and sound analytic principles to efficiently and effectively advance Air Force, DoD, and other employer logistics and supply chain management capabilities. | 1. **Critical thinking skills:** Can critically analyze situations, information, and data. |
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<td>LSCMGT.MS</td>
<td>2. <strong>Depth.</strong> Are well educated, highly-valued, and successful logistics and supply chain experts.</td>
<td>2. <strong>Problem solving skills.</strong> Can formulate problem statements, ascertain and collect the relevant data, and utilize the correct methodology in order to both delineate and solve problems in the real world.</td>
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<td>3. <strong>Professionalism.</strong> Professionally communicate technical solutions and results.</td>
<td>3. <strong>Communication Skills.</strong> Can effectively communicate to peers, subordinates, and supervisors in a professional manner both orally and in writing.</td>
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<td>4. <strong>Lifelong Learning.</strong> Continue to pursue lifelong multidisciplinary learning.</td>
<td>4. <strong>Logistics specific knowledge.</strong> Have developed a thorough understanding of the logistics, mobility, and supply chain discipline as required to make strategic level managerial decisions in the logistics areas.</td>
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<tr>
<td>OPSANLYS.MS</td>
<td><strong>Our Program Educational Objectives are to provide graduates who:</strong></td>
<td><strong>1. Critical Thinking and problem solving skills.</strong> Can discern key aspects of complex problems, problem definitions, decision criteria, success measures, as well as potential solution generating algorithms.</td>
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<td></td>
<td>1. <strong>Breadth.</strong> Apply foundational operational analysis techniques to efficiently and effectively advance Air Force or other employer capabilities.</td>
<td>2. <strong>Operations analysis specific knowledge.</strong> Have developed foundational knowledge in fundamental operations research methods and associated disciplines.</td>
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<td>2. <strong>Depth.</strong> Are well educated, highly-valued, and successful operational analysts.</td>
<td>3. <strong>Communication skills.</strong> Have developed written and oral communications skills necessary to present complex problems to a decision-making audience: problem definition, modeling methodologies, including solution advocacy that utilizes rigorous analytical support.</td>
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<td>3. <strong>Professionalism.</strong> Professionally communicate technical analytical assessments, solutions, and results.</td>
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# ENS PEOs/POs At A Glance

14 Aug 2012

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<td>LOGAIR.MS</td>
<td>Our Program Educational Objectives are to provide graduates who:</td>
<td>1. <strong>Critical thinking skills</strong>: Can critically analyze situations, information, and data.</td>
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<td>1. <strong>Breadth.</strong> Apply foundational logistics concepts and sound analytic principles to efficiently and effectively advance Air Force and DoD air mobility capabilities.</td>
<td>2. <strong>Problem solving skills</strong>: Can formulate problem statements, ascertain and collect the relevant data and utilize the correct methodology in order to both delineate and solve problems in the real world.</td>
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<td>2. <strong>Depth.</strong> Are well-educated, highly-valued, and successful logicians and air mobility officers.</td>
<td>3. <strong>Communication skills</strong>: Can effectively communicate to peers, subordinates, and supervisors in a professional manner both orally and in writing.</td>
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<td>3. <strong>Professionalism.</strong> Professionally communicate technical solutions and results.</td>
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<td>4. <strong>Lifelong Learning.</strong> Continue to pursue lifelong multidisciplinary learning.</td>
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| LOGSCI.MS                | Our Program Educational Objectives are to provide graduates who:              | 1. **Critical thinking skills**: Can critically analyze situations, information, and data. |
|                          | 1. **Breadth.** Apply foundational logistics concepts and sound analytic principles to efficiently and effectively advance Air Force and DoD logistics capabilities. | 2. **Problem solving skills**: Can formulate problem statements, ascertain and collect the relevant data, and utilize the correct methodology in order to both delineate and solve problems in the real world. |
|                          | 2. **Depth.** Are well-educated, highly-valued, and successful logicians. |                                                             |