

# DATA ANALYTICS ENGINEERING, MS

**Banner Code:** VS-MS-DAEN

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The MS in Data Analytics Engineering is designed to provide students with an understanding of the technologies and methodologies necessary for data-driven decision-making. Students study topics such as data mining, information technology, statistical modeling, predictive analytics, optimization, risk analysis, and data visualization. It is aimed at students who wish to become data scientists and analysts in finance, marketing, operations, business/government intelligence and other information intensive groups generating and consuming large amounts of data.

## Admissions & Policies

### Admissions

Applicants must have completed a baccalaureate degree from a regionally accredited program with a reputation for high academic standards and an earned GPA of 3.00 or better in their 60 highest-level credits. While no specific undergraduate degree is required, a background in engineering, business, computer science, statistics, mathematics, or information technology, is desirable, or alternatively strong work experience with data or analytics may be used. DAEN 500 Data Analytics Fundamentals may be required for students without a basic foundation in Data Analytics.

For each of the concentrations there are additional admission requirements. These are listed in the descriptions of the individual concentrations.

In addition to fulfilling Mason's admission requirements for graduate study, applicants must provide:

- Two letters of recommendation, preferably from academic references or references in industry or government who are familiar with the applicant's professional or academic accomplishments.
- Resume.
- Detailed statement of career goals and professional aspirations.
- Completed self-evaluation form.
- If the applicant's native language is not English, proof of English competency with a minimum TOEFL score of 575 for the paper-based exam or 230 for the computer-based exam.

## Requirements

### Degree Requirements

Total credits: 30

#### Core Courses

The following core coursework covers the basic elements of data analytics at the graduate level.

AIT 580	Analytics: Big Data to Information	3
CS 504	Principles of Data Management and Mining <sup>1</sup>	3
or CS 584	Theory and Applications of Data Mining	

DAEN 690	Data Analytics Project	3
OR 531	Analytics and Decision Analysis	3
STAT 515	Applied Statistics and Visualization for Analytics <sup>2</sup>	3
or STAT 554	Applied Statistics I	
Total Credits		15

<sup>1</sup> CS 504 Principles of Data Management and Mining (for all concentrations except Data Mining) or CS 584 Theory and Applications of Data Mining (for the Data Mining concentration only)

<sup>2</sup> STAT 515 Applied Statistics and Visualization for Analytics (for all concentrations except Statistics for Analytics) or STAT 554 Applied Statistics I (for the Statistics for Analytics concentration only)

### Concentrations

Students can elect a concentration that corresponds to a specialized technical area. Students not interested in a concentration can work with an advisor to select 15 credits of electives from among courses allowed in all the concentrations.

#### Concentration in Applied Analytics (APAN)

Focuses on the practical elements of adapting big data approaches to common analytic problems and government operations.

#### Additional Admission Requirements

Students entering the program should have completed the following George Mason undergraduate courses or their equivalents:

IT 106	Introduction to IT Problem Solving Using Computer Programming	3
MATH 108	Introductory Calculus with Business Applications (Mason Core)	3
STAT 250	Introductory Statistics I (Mason Core)	3

#### Required Concentration Courses

All students are required to take one fundamental course: 3

AIT 524	Database Management Systems	3
In addition, students in this concentration may choose four courses from the following list: 12		
AIT 582	Applications of Metadata in Complex Big Data Problems	
AIT 614	Big Data Essentials	
AIT 622	Determining Needs for Complex Big Data Systems	
AIT 624	Knowledge Mining from Big-Data	
AIT 664	Information: Representation, Processing and Visualization	
DAEN 698	Data Analytics Research Project	

Total Credits 15

#### Concentration in Bioengineering (BIOE)

Bioengineering, whether it is mapping the human genome or computer aided diagnosis, is an exercise in data analytics.

**Additional Admission Requirements**

Students entering the program should have completed the following George Mason undergraduate courses or their equivalents:

BENG 320	Bioengineering Signals and Systems	3
MATH 113	Analytic Geometry and Calculus I (Mason Core)	4
MATH 114	Analytic Geometry and Calculus II	4
MATH 213	Analytic Geometry and Calculus III	3
MATH 214	Elementary Differential Equations	3
STAT 346	Probability for Engineers	3

Note:

Students with some deficiencies in preparation may be admitted provisionally pending completion of foundation courses in mathematics or computer science. Undergraduate credit earned for this purpose may not be applied toward the graduate degree.

**Required Concentration Courses**

BENG 501	Bioengineering Research Methods	3
BENG 551	Translational Bioengineering	3
ECE 528	Introduction to Random Processes in Electrical and Computer Engineering	3
ECE 535	Digital Signal Processing	3
Select one from the following:		3
BENG 525	Neural Engineering	
BENG 538	Medical Imaging	
ECE 537	Introduction to Digital Image Processing (DIP)	
BENG 550	Advanced Biomechanics	
BENG 636	Advanced Biomedical Signal Processing	
DAEN 698	Data Analytics Research Project	

Total Credits 15

**Concentration in Business Analytics (BUSA)****Additional Admission Requirements**

Students entering the program must have successfully completed STAT 515 Applied Statistics and Visualization for Analytics or STAT 554 Applied Statistics I with a grade of B or better.

**Required Concentration Courses**

GBUS 720	Marketing Analytics	3
GBUS 721	Marketing Research	3
GBUS 738	Data Mining for Business Analytics	3
GBUS 739	Advanced Data Mining for Business Analytics	3
GBUS 744	Fraud Examination	3

Total Credits 15

**Concentration in Data Mining (DTM)**

Aimed at students who are interested in understanding data mining, advanced database systems, MapReduce programming, pattern recognition, decision guidance systems, and Bayesian inference as they relate to data analytics.

**Additional Admission Requirements**

Students entering the program should have completed the following George Mason undergraduate courses or their equivalents:

CS 310	Data Structures	3
CS 330	Formal Methods and Models	3
CS 367	Computer Systems and Programming	4
CS 465	Computer Systems Architecture	3
MATH 125	Discrete Mathematics I (Mason Core)	3

Note:

Students with some deficiencies in preparation may be admitted provisionally pending completion of foundation courses in mathematics or computer science. Undergraduate credit earned for this purpose may not be applied toward the graduate degree.

**Required Concentration Courses**

CS 657	Mining Massive Datasets with MapReduce	3
Select four from the following: <sup>1</sup>		12
CS 550	Database Systems	
CS 580	Introduction to Artificial Intelligence	
CS 650	Advanced Database Management	
CS 674	Data Mining on Multimedia Data	
CS 688	Pattern Recognition	
CS 775	Advanced Pattern Recognition	
CS 782	Machine Learning	
CS 787	Decision Guidance Systems	
DAEN 698	Data Analytics Research Project	
INFS 623	Web Search Engines and Recommender Systems	
INFS 740	Database Programming for the World Wide Web	
SYST 664	Bayesian Inference and Decision Theory	
Total Credits		15

<sup>1</sup> Note: all prerequisites must be met.

**Concentration in Digital Forensics (DFOR)**

Deals with the process of acquiring, extracting, integrating, transforming, and modeling data with the goal of deriving useful information that is suitable for presentation in a court of law. Digital forensics is a key component in criminal, civil, intelligence, and counter-terrorism matters. Students will be able to apply data analytics to such areas as digital media, intercepted (network) data, mobile media, unknown code, and leverage that analysis in order to determine, intent, attribution, cause, effect, and context.

**Additional Admission Requirements**

Students entering the program should have completed the following George Mason undergraduate courses or their equivalents:

**Computer Operating Systems**

IT 342	Operating Systems Fundamentals	3
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**Computer Networking**

IT 441	Network Servers and Infrastructures	3
IT 341	Data Communications and Network Principles	3
IT 445	Advanced Networking Principles	3
or TCOM 515	Internet Protocol Routing: Lecture and Laboratory Course	

Note:

Students with some deficiencies in preparation may be admitted provisionally pending completion of foundation courses in mathematics or computer science. Undergraduate credit earned for this purpose may not be applied toward the graduate degree.

#### Required Concentration Courses

CFRS 500	Introduction to Forensic Technology and Analysis	3
CFRS 660	Network Forensics	3
Select three from the following:		9
CFRS 510	Digital Forensics Analysis	
CFRS 661	Digital Media Forensics	
CFRS 663	Operations of Intrusion Detection for Forensics	
CFRS 664	Incident Response Forensics	
CFRS 698	Independent Reading and Research	
CFRS 761	Malware Reverse Engineering	
CFRS 762	Mobile Device Forensics	
CFRS 763	Registry Forensics - Windows	
CFRS 764	Mac Forensics	
CFRS 767	Penetration Testing in Computer Forensics	
CFRS 768	Digital Warfare	
CFRS 780	Advanced Topics in Computer Forensics	
DAEN 698	Data Analytics Research Project	
Total Credits		15

#### Concentration in Financial Engineering (FNNE)

The concentration emphasizes both analytical and practical aspects of financial and econometric data analytics. Students are expected to demonstrate proficiency in several quantitative modeling disciplines. Students are also expected to understand issues relevant to practical aspects of investment and hedging decision making, derivative valuation, and risk analysis. The students will learn the techniques to analyze large financial and economic data to derive meaningful knowledge, which will be useful for developing effective business and risk mitigation strategies and making sound financial, marketing, and investment decisions. The concentration prepares students for careers in business analytics with a focus on practical applications in financial operations, investment, and risk mitigation strategy development.

#### Additional Admission Requirements

Students entering the program should have completed the following George Mason undergraduate courses or their equivalents:

CS 112	Introduction to Computer Programming (Mason Core)	4
MATH 113	Analytic Geometry and Calculus I (Mason Core)	4
STAT 344	Probability and Statistics for Engineers and Scientists I	3

#### Required Concentration Courses

SYST/OR 538	Analytics for Financial Engineering and Econometrics	3
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SYST/OR 588	Financial Systems Engineering I: Introduction to Options, Futures, and Derivatives	3
SYST/OR 688	Financial Systems Engineering II: Derivative Products and Risk Management	3
Select two from the following:		6
DAEN 698	Data Analytics Research Project	
SYST/OR 568	Applied Predictive Analytics	
SYST 573	Decision and Risk Analysis	
SYST 664	Bayesian Inference and Decision Theory	
SYST/OR 671	Judgment and Choice Processing and Decision Making	
OR 604	Practical Optimization	
OR 645	Stochastic Processes	
Total Credits		15

#### Concentration in Health Data Analytics (HDAN)

Required Concentration Courses:

HAP 720	Health Data Integration	3
HAP 725	Statistical Process Control in Healthcare	3
HAP 780	Data Mining in Health Care	3
or HAP 880	Advanced Health Data Mining	
Select two from the following:		6
DAEN 698	Data Analytics Research Project	
HAP 701	Health Data: Vocabulary and Standards	
HAP 719	Advanced Statistics in Health Services Research I	
HAP 730	Health Care Decision Analysis	
or HAP 770	Medical Decision Making and Decision Support Systems	
HAP 819	Advanced Statistics in Health Services Research II	
HAP 823	Comparative Effectiveness Analysis using Observational Data	
Total Credits		15

#### Concentration in Predictive Analytics (PRAN)

The ultimate goal of analytics of Big Data is to derive value by suggesting effective actions for the future. Predictive analytics focuses on the methods for deciding on the best course of action, taken into account possible constraints and risks. The concentration will provide students with skills that drive effective decision making and optimization. Students will learn the techniques to analyze both structured and unstructured data to derive meaningful knowledge, which will be useful for developing effective strategies and making optimal decisions.

The concentration emphasizes both analytical and practical aspects of predictive analytics. Students are expected to master the practical aspects of modeling and methods for optimization. Students are also expected to demonstrate proficiency in decision making, design of decision support systems, and risk analysis. The program prepares students for careers in big data analytics with a focus on strategic decision making in practical applications including financial engineering, health care, transportation, and intelligence.

**Additional Admission Requirements**

Students entering the program should have completed the following George Mason undergraduate courses or their equivalents:

CS 112	Introduction to Computer Programming (Mason Core)	4
MATH 113	Analytic Geometry and Calculus I (Mason Core)	4
STAT 344	Probability and Statistics for Engineers and Scientists I	3

**Required Concentration Courses**

OR 604	Practical Optimization	3
SYST 542	Decision Support Systems Engineering	3
SYST 568	Applied Predictive Analytics	3
or OR 568	Applied Predictive Analytics	
SYST 573	Decision and Risk Analysis	3
Select one from the following:		3
DAEN 698	Data Analytics Research Project	
OR 603	Sports Analytics	
STAT 663	Statistical Graphics and Data Exploration I	
SYST 508	Complex Systems Engineering Management	
SYST 584	Heterogeneous Data Fusion	
SYST 664	Bayesian Inference and Decision Theory	
SYST 670	Metaheuristics for Optimization	
or OR 670	Metaheuristics for Optimization	
Total Credits		15

**Concentration in Statistical Analytics (STLA)**

Provides students with skills necessary for gaining insight from data. Enables students to evaluate large data-sets from a rigorous statistical perspective, including theoretical, computational, and analytical techniques. Emphasis will be placed on developing deep analytical talent in the two areas of statistical modeling and data visualization. "Big Data" are well-known to encompass high levels of uncertainty and complex interactions and relationships. To gain knowledge from these data and hence inform decisions, elucidation of the core interactions and relationships must be done in a manner that acknowledges uncertainties in order to both minimize false signals and maximize true discoveries. Statistical modeling does exactly this – it accounts for uncertainty while identifying relationships. Visualization is often a critical component of modeling, but visualization also stands alone as an important tool for presentation of information, decision analysis, and process improvement.

**Additional Admission Requirements**

Students entering the program should have completed the following George Mason undergraduate courses or their equivalents:

MATH 203	Linear Algebra	3
MATH 213	Analytic Geometry and Calculus III	3
STAT 346	Probability for Engineers	3
or MATH 351	Probability	

**Required Concentration Courses**

STAT 544	Applied Probability	3
STAT 554	Applied Statistics I	3
And three courses from the following:		9

DAEN 698	Data Analytics Research Project	
STAT 654	Applied Statistics II	
STAT 662	Multivariate Statistical Methods	
STAT 663	Statistical Graphics and Data Exploration I	
STAT 672	Statistical Learning and Data Analytics	
Total Credits		15

**Accelerated Master's****BS (selected)/Data Analytics Engineering, Accelerated MS****Overview**

Qualified undergraduate students have the option of obtaining an accelerated Data Analytics Engineering, MS with a concentration in predictive analytics.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 Graduate Policies.

**Admission Requirements**

While no specific undergraduate degree is required, Mason undergraduate students majoring in systems engineering or any other engineering, business, computer science, statistics, mathematics, or information technology may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30.

For the predictive analytics concentration, students must submit evidence of:

- Satisfactory completion of courses in calculus, applied probability and statistics, and a scientific programming language.
- Familiarity with analytical modeling software, such as spreadsheets or math packages.

**Accelerated Option Requirements**

Students must complete all credits that satisfy requirements for the BS and MS programs, with six credits overlap chosen from the courses in the following table. For BS candidates, these graduate courses replace the corresponding undergraduate courses listed. The undergraduate version of these courses may not be applied toward the MS degree.

Undergraduate	Graduate	
SYST 473	SYST 573	Credit may not be received for both courses.
OR 441	OR 541	Credit may not be received for both courses.

For the predictive analytics concentration, any other 500-level course may be applied to both the undergraduate and graduate degrees with approval of the advisor and SEOR department chair.

OR 541 Operations Research: Deterministic Models will substitute for the OR 531 Analytics and Decision Analysis core requirement in the MS DAE program.

## Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master's degree is conferred.

## Applied Computer Science, BS/Data Analytics Engineering, Accelerated MS Overview

Highly-qualified students in the Applied Computer Science, BS have the option of obtaining an accelerated Data Analytics Engineering, MS.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 Graduate Policies.

### Admission Requirements

Students in the Applied Computer Science, BS program may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30. Students must have successfully completed:

Code	Title	Credits
CS 310	Data Structures	3
CS 330	Formal Methods and Models	3
CS 367	Computer Systems and Programming	4
Total Credits		10

### Accelerated Option Requirements

Students must complete all requirements for the BS and MS programs, with 6 credits overlap.

Students must register for 6 credits of CS 500-level basic courses in place of the corresponding CS 400-level courses required for the undergraduate degree requirements. Specifically, students in all concentrations of the Applied Computer Science, BS program must register for:

Code	Title	Credits
CS 584	Theory and Applications of Data Mining	3
Total Credits		3

Students in the Software Engineering and Bioinformatics concentrations of the Applied Computer Science, BS program must also register for:

Code	Title	Credits
CS 550	Database Systems	3
Total Credits		3

Students in the Computer Game Design and Geography concentrations of the Applied Computer Science, BS program must also register for one of the following courses:

Code	Title	Credits
CS 550	Database Systems	3
CS 580	Introduction to Artificial Intelligence	3

Note:

For students in the Computer Game Design and Geography concentrations of the Applied Computer Science, BS program, one of the 500 level courses will count as an elective towards their undergraduate degree.

Students are permitted to take additional graduate basic courses in their undergraduate programs. In such cases, those classes cannot be counted toward requirements for the MS.

## Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master's degree is conferred.

## Bioengineering, BS/Data Analytics Engineering, Accelerated MS Overview

Highly-qualified students in the Bioengineering, BS have the option of obtaining an accelerated Data Analytics Engineering, MS with a concentration in Bioengineering.

Students in an accelerated degree program must fulfill all university requirements for the master's degree. For policies governing all graduate degrees, see AP.6 Graduate Policies.

### Admission Requirements

Students in the Bioengineering, BS program may apply to this option if they have earned 95 undergraduate credits with an overall GPA of at least 3.30. Students must have successfully completed CS 222 Computer Programming for Engineers and BENG 320 Bioengineering Signals and Systems. Criteria for admission are identical to criteria for admission to the Bioengineering concentration of the Data Analytics Engineering, MS program.

### Accelerated Option Requirements

Students must complete all requirements for the BS and MS programs, with 6 credits overlap.

Students register for 6 credits of 500-level basic courses in place of the corresponding BENG 400-level courses required for the undergraduate degree requirements. Specifically, students must register for:

Code	Title	Credits
BENG 501	Bioengineering Research Methods	3
CS 504	Principles of Data Management and Mining (in place of BENG 420)	3
Total Credits		6

Note:

Students are permitted to take additional graduate basic courses in their undergraduate programs. In such cases, those classes cannot be counted toward requirements for the MS.

## Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master's degree is conferred.

## Computer Science, BS/Data Analytics Engineering, Accelerated MS

### Overview

Highly-qualified students in the Computer Science, BS have the option of obtaining an accelerated Data Analytics Engineering, MS.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 Graduate Policies.

### Admission Requirements

Students in the Computer Science, BS program may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30. Students must have successfully completed CS 310 Data Structures, CS 330 Formal Methods and Models and CS 367 Computer Systems and Programming.

### Accelerated Option Requirements

Students must complete all requirements for the BS and MS programs, with 6 credits overlap.

Students register for 6 credits of CS 500-level basic courses in place of the corresponding CS 400-level courses required for the undergraduate degree requirements. Specifically, students must register for:

Code	Title	Credits
CS 584	Theory and Applications of Data Mining	3
Select one of the following courses in place of the corresponding 400-level courses:		3
CS 550	Database Systems	
CS 580	Introduction to Artificial Intelligence	
Total Credits		6

Note:

Students are permitted to take additional graduate basic courses in their undergraduate programs. In such cases, those classes cannot be counted toward requirements for the MS.

## Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master's degree is conferred.