### MS Business Analytics – Customer Analytics Track (MSCA)
#### 2019-2020 Academic Year

#### List of Courses by Semester

**Preprogram Foundation Requirements**
Preparatory work begins in July/August, is in addition to required credits and does not affect GPA.

**Required:**
- Coursera online Introduction to Marketing Course
- MKT 500V Basics of R Programming (0.5)

**Choose at least one of:**
- MKT 500R Basics of Statistics Using SPSS (0.5)
- MGT 574 Basics of Stata programming (0.5)
- MGT 573 Basics of SAS programming (0.5)

#### Fall Semester (12 Core + 3 Track Required = 15 credits)

**Fall A**
- **Required:**
  - MGT 560G Database Design and SQL (1.5)

**Track Required:**
- MKT 571A Marketing Research (1.5)

**Fall B**
- **Required:**
  - MGT 560M: Big Data and Cloud Computing (1.5)
  - OMM 500N: Prescriptive Analytics (1.5)

**Track Required:**
- MKT 571B Advanced Marketing Research (1.5)

**Required:**
- MGT 560F Professional Business Communication (1.5)
- MKT 500S Predictive Analytics for Business Decision-Making (3)
- OMM 561 Introduction to Python and Data Science (3)

#### Spring Semester (6 Core + 7.5-10.5 Track Required = 13.5-16.5 credits)

**Spring A**
- **Track Required:**
  - MKT 555A Data Analysis for Brand Management (1.5)
  - MKT 500U Digital Marketing (1.5)**

**Spring B**
- **Track Required:**
  - MKT 555 Analytics-Driven Brand Management (1.5)

**Required:**
- MKT 500W Causal Inference (3)
- MKT 500T Customer Analytics Using Probability Models (3)
- MKT 500Q Intensive Industry Project or MKT 500Q during Fall 2019 (3)

**Final Fall Semester (3-6 track + 4.5 electives (see page 2) = 7.5-4.5 credits)**

**Fall A**
- **Track Required:**
  - MKT 577 Marketing Strategy (3)

**Fall B**
- **Track Required:**
  - MKT 500Q Intensive Industry Project or MKT 500Q during Spring 2019 (3)

**Total 39 credits: 18 common core, 13.5 track required, 4.5 electives**
Core Analytics Courses
A total of 18 credits are common to all tracks and build your analytics knowledge base.

The first fall semester introduces key concepts and tools including Database Design and SQL and Big Data and Cloud Computing, as well as:

- **Intro to Python and Data Science** introduces programming language to acquire, clean, analyze, and visualize data (descriptive analytics) for reporting and complex optimization.
- **Predictive Analytics** covers advanced analytic techniques such as neural networks and stochastic gradient boosting to convert raw and messy business data into robust predictions of future customer behavior or critical organizational elements.
- **Prescriptive Analytics** builds upon the descriptive and predictive analytics course work through the use of optimization models and software tools to suggest decision options for a wide variety of business decisions (course is called Optimization for Business in the MSAA track).

In addition, Managerial Communication introduces students to fundamental best practices in business writing and speaking.

Core requirements conclude in the spring with an Introduction to Cybersecurity and two advanced analytic topics:

- **Causal Inference** teaches statistical and experimental methods to identify casual relations among data sets and reject prescriptive options based on biased samples or reverse causality.
- **Text Mining** provides techniques, algorithms, and tools for collecting, organizing, summarizing, and analyzing textual data for topic and sentiment analysis and predictive modeling.

Electives for MS Business Analytics in Customer Analytics:

- MGT 460: Sports Business Analytics
- MGT 566: Data Analytics in Healthcare (3)
- OMM 520: Revenue Management (3)
- INFO 5500: Enterprise Resource Planning (3)
- INFO 558: Applications of Deep Neural Networks (3)
- CSE 514A: Data Mining (3) (or CSE 417T Intro to Machine Learning (3))
- CSE 557A: Information Visualization (3)
- CSE 222S: Internet of Things (3)
- CSE 515T: Bayesian Methods in Machine Learning (3)
- CSE 530S: Database Management Systems (3)
- OMM 500M: Stochastic Models (1.5)
- MSB 550: Introduction to Bioinformatics (3)
- MATH 420: Experimental Design (3)

*All letter graded courses, count towards degree and GPA calculation. Math and some CSE courses can be taken Pass/Fail and count towards degree.*

**Note:** Only 12 hours of approved CSE courses may count toward degree requirements.

**Note to International students:** Additional English courses may be required or waived upon arrival. If taken, these courses are over and above required credits, are graded on a pass/fail basis, and do not count towards a student’s GPA calculation.

Students may take up to 19.5 credits of business coursework in the fall and spring semesters under the flat tuition rate.

The degree requirements and policies in this document apply to MSCA students entering Washington University during the 2019-20 academic year. Every effort is made to ensure that the information is accurate and correct as of the date of publication (11/26/18). Washington University reserves the right to make changes at any time without prior notice. Therefore, this curriculum document may change from time to time without notice. The governing document at any given time is the then-current version, as published online.
MSA - Customer Analytics Course Descriptions

Summer Foundations Courses – Required

**MKT 500V Basics of R Programming**

R has become the tool of choice for many data science and customer analytics professionals in every industry and field. It is not surprising to see a requirement for being familiar with R in job descriptions. R is very flexible in carry out data analysis. Part of the benefit of being open source is that many programmers/researchers are constantly introducing new statistical analysis tools into R through R packages. Given all the benefits, R does have a relatively steeper learning curve. To better prepare MSA students, we introduce this 2 day introduction to R programming course. This class will help you master the basics of R. We will start from the very beginning - installation of the program. No prior knowledge in programming is required. Through in class demonstration and lots of hands-on practice, by the end of the second day, you will have the chance to undertake your own data analysis and solve relevant business problems using R. 0.5 Credits. Graded Pass/Fail.

Summer Foundations Courses – Choose at least one of the following:

**MKT 500R Basics of Statistics Using SPSS**

This foundational course, which is a required course for students in the MSA program, will cover material that serves as useful preparation for courses offered in the Olin curriculum that rely extensively on applied statistical concepts (e.g., marketing research, advanced marketing research, database marketing, data analysis for brand management etc.). The course will provide students with both an overview of basic statistical concepts and a practical grasp of statistical analysis. Students will be trained to use SPSS, a popular statistical software package, in order to perform the statistical analysis. The course will also cover interpretation of results. 0.5 Credits. Graded Pass/Fail.

**MGT 573 Basics of SAS Programming**

Statistics using SAS serves as a technical basis for research and data analysis. This course will provide students with an overview of statistical knowledge and with a good practice of analysis techniques. Students will be trained to use SAS, one of the most commonly used tools in commercial analytics markets, to analyze data and interpret results. The course aims to prepare students for more advanced courses in data analytics. Graded pass/fail.

**MGT 574 Basics of Stata Programming**

As one of the most popular statistics software packages, Stata has served as an essential tool of data science in every industry and academia. The goals of the course are to better prepare students for success in future courses and careers. Students will be trained to obtain necessary technical skills of using Stata by the end of this two-day course. The introduction of Stata will be from the very beginning, and therefore there is no prerequisites required. Basic statistics foundations will be reviewed to facilitate the goals of the course. Graded pass/fail.
Required Core Courses

MGT 560G  Database Design and SQL

Databases are at the foundation of every organization's information strategy. Understanding the structure of databases and mastering the tools to analyze data are essential skills in any role. The tools developed in this course assist students in implementing a company's data management strategy and developing well-grounded analytical recommendations. In this course we focus on understanding how data is structured in relational databases. With vast amounts of data available, from disparate sources, effective organization of the data is essential to its utilization. To complement this, we utilize SQL (Structured Query Language) as the primary tool to extract data for managerial reports and for advanced analytical models. Practical experience with current relational database software is developed throughout the course. This course is required for MS/CA students and priority will be given to SMP students. 1.5 Credits.

OMM 500N  Prescriptive Analytics

This course covers optimization models and tools as they apply to the design and analysis of supply chains. Production planning, distribution, network design, and revenue management problems are covered using the methods of linear, non-linear, and integer programming. Upon successful completion of this course, students will demonstrate competency in formulating and solving supply chain optimization models of real-life complexity using state-of-the-art software. They will become proficient with industrial strength software tools like AMPL and Gurobi alongside Excel's Solver. The course emphasizes proficiency in model-building and using software tools rather than theory. 1.5 Credits

MGT 560F  Professional Business Communication

Communication is the process of sending and receiving messages, however, communication is effective only when the message is understood and when it stimulates action or encourages the receiver to think in a new way. This course will introduce students to fundamental best practices in business writing and business speaking that will ensure effective communication. Students will participate in activities that will develop professional business communication skills in both writing and speaking. These will include: preparing, writing and delivering presentations, composing clear concise business messages in a variety of formats, understanding emotional intelligence to reach the audience and utilizing critical thinking as a basis for communication strategies. 1.5 Credits.

MKT 500S  Predictive Analytics for Business Decision-Making

Predictive Analytics deals with the employment of formal learning from business experience, using business data, to predict the future behavior of customers or other critical organizational elements in order to drive better business decisions. This course emphasizes data situations that students are likely to face in marketing, finance, manufacturing and consulting jobs. Students will analyze real-world business datasets using various advanced analytic techniques such as logistic regression, decision trees, neural networks, stochastic gradient boosting, MARSplines, Ensembles, Clustering, Associations etc. The focus of the course lies in the conversion of raw and messy business data in to robust actionable predictions for decision-making. 3 credits.
OMM 561 Introduction to Python and Data Science

This is a 3-credit course offered to MSBA students. It provides students the necessary skill set to extract reliable insights from large datasets prevalent in various business applications, such as supply chain management, marketplace operations, healthcare analytics and financial engineering, using Python. In this course, students will develop basic tools to understand Python programs and implement data processing pipelines using Python. In particular, students will learn how to acquire, clean, analyze and visualize data in Python, which they will then use to improve decision-making processes. Throughout the course, students will use the Python programming language, which is very effective for data manipulation, reporting, and complex optimization. Topics covered include introduction to Python programming, data acquisition and cleaning, data manipulation, current multi-source data collection technology used in practice, basic data visualization using Matplotlib, ggplot2 and Bokeh. 3 Credits.

MGT 560M Big Data & Cloud Computing

The growth in available data is a challenge to many companies. This presents an opportunity for companies to conquer the vast and various data available to them. The growth in data includes traditional structured data, as well as unstructured data created by both people and machines. It is essential for analysts to be comfortable in the new technologies and tools that are being developed to store, retrieve, analyze, and report, using the vast data resources available. This course introduces students to the technologies currently deployed to overcome the challenges of Big Data. Prerequisite: MGT 560G.

MGT 561 Text Mining

Consumers and companies constantly generate large amounts of unstructured or lightly structured texts on the web and offline: exchanges of consumer opinions on products and services on social media, transcripts of phone conversations with customer representatives, open-ended surveys, etc. By employing text analytics, businesses can derive at scale valuable insights into consumer attitudes to brands, competitive landscape, and customer relationships, among other applications. This course introduces students to the methods of mining, organizing, summarizing, and analyzing textual data with the objective of driving business decision-making. In particular, the course will cover the following substantive topics:
- Sources of business-relevant text data and web crawling;
- Topic analysis;
- Sentiment analysis;
- Use of text in predictive modeling (churn analysis, predicting CTR with search terms);
The focus of the course is on understanding and hands-on implementation of relevant algorithms and techniques, but the course will provide the opportunity to use a number of (open-source) software tools.

MGT 560N Introduction to Cybersecurity

This course covers a broad range of cyber security terms, definitions, perspectives, concepts, and current trends with a focus on managing risk and the use of information and cyber security as business enablers. Students will complete a cybersecurity analytics-related project as part of the coursework.
**MKT 500W Causal Inference**

This course introduces students to causal inference. The advance in information technology has given an enormous amount of valuable data to businesses. Data analysts and data scientists have become the cool kids due to high demand in data talents. In the meantime, however, artificial intelligence is getting better at finding correlational patterns in data. This means that AI may even replace some tasks performed by data scientists in the coming years.

The good news is that good data-driven decision making often goes beyond discovering correlations in the data. In particular, making the right prescriptive decisions often requires managers to tease out the causal relationship(s) between the prescriptions and outcomes of interest. Artificial intelligence has yet to show such abilities. Therefore, mastering causal inference is likely to become more rewarding over time as AI continues to complement human judgement with quick data analyses at a low cost.

Throughout the course, we will go over many examples of why understanding causal relationships is important. Spoiler alert: in one example, Lewis, Rao, and Reiley (2012) find that a naïve estimation could show that advertisement leads to an 870%--1,200% increase in consumers’ likelihood of search for the advertised brand, while the true causal effect is 0. Imagine how disastrous it would be if companies make advertising decisions based on false causal inferences!

Our goals in the course are
- Use proper statistical tools to tease out the deterministic process that have generated the data in the presence of randomness.
- Become skeptical about claims of causality. You should be able to give alternative data generating processes that could have generated the same data.
- Understand that observational data come from agents’ decisions, and that these decisions could lead to biased samples.
- Understand omitted variable bias and reverse causality
- Design and implement various statistical and experimental methods of addressing the basic causal-inference problem using statistical software.
- Dig deeper into the mechanisms (decision trees) that yield the causal relations.
- Articulate analyses in presentations.

3 Credits

**MKT 577 Marketing Strategy**

Marketing strategic decisions require long-term planning and are often costly to change once implemented. They often involve more than one marketing mix variable (price, advertising and other promotions) that have to be consistent with a firm’s core competencies, with the objective of establishing sustainable competitive advantages. A good strategic planning requires careful analysis of customers and competitors in the industry, identifying a feasible set of options and deciding on a course of actions. With the development of the information technology nowadays, firms have collected valuable market data, either by themselves or from third-party data providers. The biggest question for most firms, however, is how to use these data to help make strategic decisions. The objective of this capstone course is to develop a comprehensive framework to help understand the strategic situations of firms and the trade-off involved in decision-making. It will also provide students a comprehensive knowledge of using analytical skills to solve business problems. We will explore the importance of CRM and how to use customer analysis to make marketing decisions. Other topics
including competitor analysis, STP, price competition, product and entry strategies will also be covered. 3.0 credits.

**Required Track Courses**

**MKT 571A Marketing Research**

This introductory marketing research course examines the role of marketing research in the formulation and solution of marketing problems. In this course, students develop and apply basic skills in conducting and evaluating marketing research design. The first part of the course will focus on data collection from consumers using techniques such as focus groups, surveys, experiments etc. The second part will focus on basic analysis of the collected data using techniques such as t-tests, chi-square, and linear regression. Students will apply and implement these techniques using standard statistical software. 1.5 Credits.

**MKT 571B Advanced Marketing Research**

This course is a follow-up to MKT 571A and is designed to develop advanced techniques in marketing research and analysis. In this course, students will advance their skills in conducting marketing research and analyzing data using sophisticated multivariate techniques such as conjoint analysis, multidimensional scaling, cluster analysis, etc. These analyses will give students the tools to conduct a variety of advanced marketing analyses, such as segmentation and perceptual mapping. The course will teach students how to implement these techniques using standard statistical software. 1.5 Credits.

**MKT 555A Data Analysis for Brand Management**

Today's brand managers typically have access to large quantities of data. For example, managers of consumer packaged goods brands typically have access to supermarket scanner data that cover thousands of daily transactions in hundreds of product categories at the store. Careful analyses of such data lead to an improved understanding of the marketplace and, in turn, improve the quality of marketing decisions. This course will cover statistical models and techniques that can be effectively used by brand managers on large marketing datasets. While the focus will be on fast-moving packaged goods categories (coffee, laundry detergents, carbonated beverages, etc.), the course will also deal with durable goods (automobiles), entertainment products (movies), etc. Microsoft Excel will be used for analysis. 1.5 Credits.

**MKT 500U Digital Marketing**

The aim of this course is to provide a rigorous and comprehensive introduction to technology and methods of conducting marketing activities online. Specific objectives are to introduce students to: (1) Concepts and terminology of digital marketing; (2) Specifics of online consumer behavior and internet-
based business models; (3) Hands-on experience in creating and running advertising campaigns in social media. 1.5 Credits.

**MKT 500T Customer Analytics Using Probability Models**

Customer analytics is about using customer data to make business decisions and predict future behavior. This course will build and implement powerful and leading-edge models for customer acquisition, retention, behavioral patterns such as website visits, customer lifetime value and direct marketing responses. The course will provide a unifying framework for thinking about customer data analysis and develop hands-on experience in model building and estimation using Microsoft Excel. These models use basic building blocks from probability theory to offer behaviorally plausible perspectives on what people buy, when they buy, and how much they buy. Anyone with interest in the revenues generated by customers (such as managers, consultants, analysts and investors) can benefit from deeper insights and more accurate forecasts that result when accounting for these patterns in their models. 3 Credits.

**MKT 500Q Intensive Industry Project**

Students will work in teams on an analytics-driven client project, applying the tools that they learned in their Fall course work to the client’s data-driven business problem under faculty and client supervision. Each student is expected to spend about 150 hours on the project. Grades are based on the quality of the final deliverables, i.e., written report and oral presentation. 3 Credits.

**MKT 555 Analytics-Driven Brand Management**

This course will cover decision support tools that can be effectively used by brand managers to improve the quality of their marketing decisions, such as pricing, advertising, promotions, etc. These decision-support tools typically rely on market-based estimates of demand and competitive conditions, which are often obtained by analyzing historical transactions data (which is the focus of MKT 555A: Data Analysis for Brand Management) and sometimes using consumer surveys (which is the focus of MKT 571A: Marketing Research I). The focus of this course will be on the optimization of marketing resources and budgets given such a quantitative understanding of the marketplace. While the focus will be on fast-moving packaged goods categories (coffee, laundry detergents, carbonated beverages, etc.), the course will also deal with durable goods (automobiles), entertainment products (movies), etc. Microsoft Excel will be used for analysis. 1.5 Credits.

**Electives**

**MGT 460I Sports Business Analytics**

This course introduces students to business analytics through sports-themed applications, academic research pertaining to sports topics, class readings, and guest lecturers from industry. Objectives for students include: 1) learning estimation and forecasting skills/trends used in sports; and 2) develop critical thinking skills necessary to assist managerial decision making to augment the performance of sports teams, leagues, or companies. 1.5 Credits.

**MGT 566 Data Analysis in Healthcare**
This is the capstone course for the Health Management major where students learn to apply rigorous statistical and analytical approaches to research questions in health services, but not limited to questions relating to management, finance and economics, operations, and policy. Faculty will identify several available research project options, and present these options in class. The goal is to capitalize on the strength of the university medical school and affiliated medical centers, in addition to capitalizing on existing relationships between Olin and healthcare firms to identify the student research projects. Students will also be encouraged to formulate their own research question and to identify potential data sources they could use to address these questions, if they so desire. Students will work in teams of 3-4, using the approach developed for the Practicum and Hatchery courses. 3 Credits.

OMM 520 Revenue Management

INFO 5500 Enterprise Resource Planning

This course introduces participants to integrated business processes through the application of SAP modules supporting Sales and Distribution (SD), Materials Management (MM), Financial Accounting (FI), Production Planning (PP), and Controlling (CO) as components of the SAP integrated business solution. During the course, each student will complete exercises to construct a functioning company operating in an integrated SAP environment. The exercises provide a guide through the concepts and creation of applications supporting the business functions of the company. 3 Credits.

INFO 558 Applications of Deep Neural Networks

Deep learning is a group of exciting new technologies for neural networks. Through a combination of advanced training techniques and neural network architectural components, it is now possible to create neural networks of much greater complexity. Deep learning allows a neural network to learn hierarchies of information in a way that is like the function of the human brain. This course will introduce the student to computer vision with Convolution Neural Networks (CNN), time series analysis with Long Short-Term Memory (LSTM), classic neural network structures and application to computer security. High Performance Computing (HPC) aspects will demonstrate how deep learning can be leveraged both on graphical processing units (GPUs), as well as grids. Focus is primarily upon the application of deep learning to problems, with some introduction mathematical foundations. Students will use the Python programming language to implement deep learning using Google TensorFlow and Keras. It is not necessary to know Python prior to this course; however, familiarity of at least one programming language is assumed. This course will be delivered in a hybrid format that includes both classroom and online instruction.

CSE 501N Programming Concepts and Practice

An introduction to software concepts and implementation, emphasizing problem solving through abstraction and decomposition. Introduces processes and algorithms, procedural abstraction, data abstraction, encapsulation, and object-oriented programming. Recursion, iteration, and simple data structures are covered. Concepts and skills are mastered through programming projects, many of which employ graphics to enhance conceptual understanding. Java, an object-oriented programming language, is the vehicle of exploration. Active-learning sessions are conducted in a studio setting in which students interact with each other and the professor to solve problems collaboratively. Prerequisites: Comfort with algebra and geometry at the high school level is assumed. Patience, good planning, and organization will promote success. This course assumes no prior experience with programming. 3 Credits.

CSE 503S Rapid Prototype Development and Creative Programming
This course uses web development as a vehicle for developing skills in rapid prototyping. Students acquire the skills to build a Linux web server in Apache, to write a web site from scratch in PHP, to run an SQL database, to perform scripting in Python, to employ the AngularJS web framework, and to develop modern web applications in client-side and server-side JavaScript. The course culminates with a creative project in which students are able to synthesize the course material into a project of their own interest. The course implements an interactive studio format: after a formal presentation of a topic, students develop a related project under the supervision of the instructor. 330S and 503S share the same lecture.

**CSE 514A Data Mining**

With the vast advancement in science and technology, data acquisition in large quantities are routinely done in many fields. Examples of large data include various types of data on the internet, high-throughput sequencing data in biology and medicine, extraterrestrial data from telescopes in astronomy, and images from surveillance camera in security. Mining a large amount of data through data mining has become an effective means to extracting knowledge from data. This course introduces the basic concepts and methods for data mining and provides hands-on experience for processing, analyzing and modeling structured and unstructured data. Homework problems, exams and programming assignments will be administrated throughout the course to enhance the learning. 3 Credits

**CSE 517A Machine Learning**

This course assumes a basic understanding of machine learning and covers advanced topics at the frontier of the field in-depth. Topics to be covered include kernel methods (support vector machines, Gaussian processes), neural networks (deep learning), and unsupervised learning. Depending on developments in the field, the course will also cover some advanced topics, which may include learning from structured data, active learning, and practical machine learning (feature selection, dimensionality reduction). 3 Credits.

**CSE 427S Cloud Computing with Big Data Applications**

This course provides a comprehensive introduction to applied parallel computing using the MapReduce programming model facilitating large scale data management and processing. There will be an emphasis on hands-on experience working with the Hadoop architecture, an open-source software framework written in Java for distributed storage and processing of very large data sets on computer clusters. Further, we will make use of related big data technologies from the Hadoop ecosystem of tools, such as Hive, Impala, and Pig in developing analytics and solving problems faced by enterprises today. 3 Credits

**CSE 557A Information Visualization**

We are in an era where it is possible to have all of the world's information at our fingertips. However, the more information we can access, the more difficult it is to obtain a holistic view of the data or to determine what's important to make decisions. Computer based visualization systems provide the opportunity to represent large and/or complex data visually to aid comprehension and cognition. In this course, we study the principles for transforming abstract data into effective information visualizations. We learn about the state-of-the-art in visualization research and development, and we gain hands-on experience with designing and developing information visualizations. We also learn how to critique existing visualizations and how to evaluate the systems we build. Readings will include current research papers from the Information Visualization community. 3 Credits.

**CSE 222S Internet of Things**
For a very long time, the Things in our world have lived relatively lonely and single-purposed lives. With the advent of the Internet of Things, we can address, control, and interconnect these formerly isolated devices to create new and interesting applications. In this course we study Bluetooth Low Energy, one of the fundamental networking technologies behind Internet-of-Things devices, and Appcessories, which include smart watches, health monitors, toys, and appliances. In addition to learning about the Bluetooth Low Energy protocol and network stack, students gain hands-on experience developing multi-platform solutions that control and communicate with Things using an accompanying app on a mobile device. Students apply their knowledge and skill to develop a project of their choosing using topics from the course. Prereq: CSE 132 3 Credits.

**CSE 515T Bayesian Methods in Machine Learning**

This course will cover machine learning from a Bayesian probabilistic perspective. Bayesian probability allows us to model and reason about all types of uncertainty. The result is a powerful, consistent framework for approaching many problems that arise in machine learning, including parameter estimation, model comparison, and decision making. We will begin with a high-level introduction to Bayesian inference, then proceed to cover more-advanced topics. These will include inference techniques (exact, MAP, sampling methods, the Laplace approximation, etc.), Bayesian decision theory, Bayesian model comparison, Bayesian nonparametrics, and Bayesian optimization. Prerequisites: CSE 417T, ESE 326 3 Credits.

**CSE 530S Database Management Systems**

A study of data models and the database management systems that support these data models. The design theory for databases is developed and various tools are utilized to apply the theory. General query languages are studied and techniques for query optimization are investigated. Integrity and security requirements are studied in the context of concurrent operations on a database, where the database may be distributed over one or more locations. The unique requirements for engineering design databases, image databases, and long transaction systems are analyzed. Prerequisite: CSE 247. 3 Credits.

**CSE 247 Data Structures and Algorithms**

Study of fundamental algorithms, data structures, and their effective use in a variety of applications. Emphasizes importance of data structure choice and implementation for obtaining the most efficient algorithm for solving a given problem. A key component of this course is worst-case asymptotic analysis, which provides a quick and simple method for determining the scalability and effectiveness of an algorithm. Midterm evening exams at which attendance is required will be held on the evenings of Monday, 10/1/18 and Monday, 11/5/18 from 6:30-8:30 p.m. Prerequisite: CSE 131 3 Credits.

**MGT XXX Introduction to Blockchain**

**HRM XXX People Analytics**

**MKT 558 Pricing Strategies**

This course is designed to equip you with some essential concepts and techniques needed to make profitable decisions about one of the most important marketing variables—price. This course is structured around four fundamental factors that firms need to consider in their pricing decisions: costs, customers, competitors, and climate (legal environment). Through case studies, in-class discussions, and course project/presentations, this course will provide you with a conceptual framework, grounded
in modern economics and consumer psychology, for analyzing a complex marketing environment and designing proactive pricing strategies that are most profitable for a business. 1.5 Credits.

HRM XXX People Metrics

MKT 558B Pricing Decision Making & Implementation

The focus of this course is on pricing tactics and strategies that are proven to be profitable for firms. Through case studies, lectures, a pricing simulation game, and presentations, this course will help students gain insights in to successful pricing strategies in various industries and to develop skills that are necessary to make the most important business decision—pricing—in their organizations. Topics of discussion include pricing innovative products, pricing and market making on the internet, pricing of digital products, and dynamic and competitive pricing. 1.5 Credits.

MGT 620 Empirical Methods in Business

CD Not listed in WebSTAC

OMM 500M Stochastic Models

This course covers the two key types of simulation models of uncertain events: Monte Carlo simulation and Discrete Event Simulation. The conceptual difference between these simulation methodologies is in their treatment of time. Discrete Event Simulation is used to model dynamic systems where events occur at specified, random, time. In Monte Carlo simulation the timing of events is typically inconsequential. Upon successful completion of this course, students will demonstrate competency in formulating and analyzing stochastic models using state-of-the-art simulation software. They will become proficient with software tools like Arena for Discrete Event Simulation and Crystal Ball for Monte Carlo simulation. The course emphasizes proficiency in using software tools to analyze models rather than theory. 1.5 Credits.

MSB 550 Introduction to Bioinformatics

This course is designed to provide broad exposure to the basic concepts, methodology and application of bioinformatics to solve biological problems. Specifically, students will learn the basics of online genomic databases and database mining tools, and acquire understanding of mathematical algorithms in genome sequence analysis (alignment analysis, gene finding/predicting), gene expression microarray (genechip) analysis, and of the impact of recent developments such as protein microarrays or whole-genome DNA chips for genome-wide association studies. Students will also take computer labs and learn basics of bioinformatics tools and databases (BLAST/WUBLAST, Prospector, etc.), practice basics of R/Bioconductor programming, and apply specialized R packages to solve bioinformatics problems pertinent to real medical research of human diseases. Auditors will not have access to the computer lab sessions. 3 Credits.

MATH 420 Experimental Design

A first course in the design and analysis of experiments, from the point of view of regression. Factorial, randomized block, split-plot, Latin square, and similar design. 3 Credits

MATH 475 Statistical Computation
Applied statistics using SAS. An introduction to SAS and SAS programming; contingency tables and Mantel-Haenszel tests; general linear models and matrix operations; simple, multilinear, and stepwise regressions; ANOVAs with nested and crossed interactions; ANOVAs and regressions with vector-valued data (MANOVAs). Topics chosen from discriminant analysis, principal components analysis, logistic regression, survival analysis, and generalized linear models. Prior acquaintance with SAS at the level introduced in Math 3200 is assumed. 3 Credits.

**MEC 537 Data Analysis, Forecasting and Risk Analysis**

This course presents a modern and contemporary coverage of several econometric models that are used for the analysis and forecasting of business data. The basic building blocks for the analysis are regression time series models. Broad coverage of non-seasonal and seasonal ARIMA models is included. The important family of ARCH-GARCH models, used to represent changing volatility, are also covered in detail. These models are widely used in option pricing and in other financial applications. The course includes some extensions of these models to multivariable problems. Students are exposed to numerous real data sets in class and in assignments. All the models are analyzed with a popular econometrics software package that is employed in business. A group project is required. 3 Credits

**CSE 502N Algorithms and Data Structures**

Study of fundamental algorithms, data structures, and their effective use in a variety of applications. Emphasizes importance of data structure choice and implementation for obtaining the most efficient algorithm for solving a given problem. A key component of this course is worst-case asymptotic analysis, which provides a quick and simple method for determining the scalability and effectiveness of an algorithm. 3 Credits.

**CSE 316A Social Network Analysis**

This course looks at social networks and markets through the eyes of a computer scientist. We will look at questions including, "Why are acquaintances rather than friends more likely to get us job opportunities?" and, "Why do the rich get richer?" We begin by studying graph theory (allowing us to study the structure) and game theory (allowing us to study the interactions) of social networks and market behavior at the introductory level. Among other topics, we will study auctions, epidemics, and the structure of the Internet (including web searches). This course examines the intersection of computer science, economics, sociology, and applied mathematics.

**CSE 417T Introduction to Machine Learning**

This course is a broad introduction to machine learning, covering supervised learning, unsupervised learning, decision-making under uncertainty, and reinforcement learning. Topics that will be covered include generative and discriminative techniques for classification (likely including regression, Naive Bayes, decision trees, neural networks, nearest-neighbor methods, support vector machines, and boosting), clustering and dimensionality reduction, dynamic programming, and temporal difference methods. Note that there is some overlap with topics in the 500-level courses on Artificial Intelligence and Machine Learning, but the material covered in this class will be at a more elementary level. 3 Credits.