GREAT with Data Course Options - 2020

Data Science Course Topics

1. **Analytics of Advanced Building Design -** Buildings are becoming much more than a destination, they are also serving as a hub for energy transformation – sitting at the intersection of energy use, energy management systems, and energy generation. Buildings also serve as a generator of myriad data and datasets that, when unlocked, can drive more actionable insights than were ever possible before. This course will focus on low- and mid-rise residential and office buildings as well as high-rise commercial buildings, to identify new technologies, opportunities, and gaps to enable this transformation. The addition of sensors and controls has changed how buildings are evolving as they become a flexible asset and a part of the grid of the future.
2. **Analytics for Customer Adoption and Preferences –** This course provides background about the different analytical techniques used to develop propensity models used to assess customer preferences and technology adoption studies. The course will review the application of a variety of methods from basic time series models and point forecasts to more sophisticated machine learning techniques including logistic regression, decision tree, and neural networks. A review of data types, data sources, and how to apply technology and customer attributes when developing propensity models will be reviewed.
3. **Analytics of Load Research -** The course provides a background in the fundamentals of customer load data analysis covering statistical methods, analytical techniques, and experimental design concepts used by the utility industry to estimate class and customer segment load shapes. Class load shapes form the basis for allocating fixed and variable costs to assess cost of service. Students will learn how utilities develop load profiles for use in applications such as marketing, planning and rate design. Students will benefit from understanding how load shapes are applied in impact assessment studies to design programs for meeting energy efficiency, demand response, and electrification objectives. The concepts will also be extended to show how utilities apply these loads shapes for use in average and marginal cost of service studies and ultimately, rate design.
4. **Anomaly Detection Techniques and Methods -** This course reviews methods to identify and quantify data that deviates from what is expected as inferred from underlying relationships. Such methods are particularly powerful in the context of Situational Awareness when applied to large amounts of time-series data, though there are many other applications where these techniques are appropriate. Participants will learn several key techniques and algorithms that are commonly used for anomaly detection including the underlying mathematical reasons behind their use. Several application examples will be explored and tested to provide participants with tips and tricks on how to apply these techniques.
5. **Big Data Analytics for Electric Power Distribution Systems –** This course focuses on applications of predictive analytics on smart electric power distribution systems and the use of Large Scale (Big) Data Analytical methods and their application to electric distribution system analysis and design. The basics of big data analytics and the electric power distribution system will be introduced. Four data-driven applications in electric power distribution systems will be studied closely. These include 1) Distribution system topology identification using smart meters data; 2) Anomaly detection in power distribution systems; 3) Load and demand response forecasting; and 4) Predictive maintenance of transformers.

6. **Computational Efficiency for Data Analytics –** This course review computational requirements of different analytical algorithms and provides context to how and when they can be used. It will provide students insight in how to identify the computational requirements for an algorithm, deal with issues related to Random Access Memory (RAM), and utilize code parallelization for a range of data analytics problems. Tips and trips on improving algorithmic efficiency will be provided.
7. **Fundamentals of Data Governance -** This course is an introduction to Data Governance and its role as a part of overall Data Management. The framework for Data Governance will be examined and examples pertaining to specific electric power industry concerns will reviewed. Topics include, the foundational elements of Data Governance, the role of data owners and data stewards, how to develop a Data Governance framework and operating model, how to structure policies and procedures, how Data Governance interacts with Data Management, as well as many other topics.
8. **Fundamentals of GIS –** Explore the world of spatial analysis and cartography with geographic information systems (GIS). In this class, participants will learn the basics of the industry's leading software tools like ArcGIS and others. Learn how GIS grew from paper maps to the globally integrated electronic software packages of today. Insights into the foundational concepts of GIS, how to analyze data, and make a map. Participants will gain the skills needed to succeed in using GIS systems. Typical utility uses cases of GIS applications will be explored.
9. **Introduction to Data Analytics -** This course is intended to provide foundational information and practical steps to increase someone's knowledge data analytics. The course will provide sample data analytics use cases in the electric power industry, introduce data science techniques, and provide information on available resources for deeper learning. This course is intended to assist people with diverse backgrounds, interests and skills, from analysts to engineers to data scientists.
10. **Load Forecasting Analytics –** This course reviews analytics methods used in short-term power system load forecasting for system operations. The course will review methods for both load and variable generation resources including wind and solar. It will provide an overview of physical models and statistical model for probabilistic load forecasting. Topics such as weather normalization, data processing and visualization, model training, and performance metrics will be reviewed.
11. **Machine Learning 101 for the Electric Power Industry –** This course introduces machine learning to people of all backgrounds by introducing common terminology and example applications for a variety of data driven computational tools and algorithms used in big data analytics. Participants will learn about data manipulation, model training, supervised and unsupervised algorithms, and deep learning by exploring sample use cases of machine learning in the electric power industry. Example visualization techniques and performance metrics will also be explored.

Cyber Security Course Topics

12. **Cyber Security for Distributed Energy Resources -** This course introduces foundational knowledge of securing distributed energy resources for utility security and engineering professionals. It includes the basic architectures, technologies, and concepts used to secure distributed energy resources. It also includes some of the operational pitfalls and lessons learned when considering the security of these types of resources.
13. **Cyber Security for Utility Executives (Cyber for the C-Suite) -** This course covers the foundational knowledge to understand the complex risks exposed by cyber security to the utility industry as it applies to utility executives. It covers basic threat types, technologies, terminologies, and cyber security concepts and how they apply to corporate risk, as well as strategies for how to evaluate the health and completeness of an organization's security apparatus.
14. **Cyber Security Fundamentals for Power System Professionals (Cyber 101) -** This course introduces the foundational knowledge of cyber security and information security in layman's terms for people of all backgrounds. It includes some of the basic technologies, terminologies, and concepts used by the cyber security industry and provides an overview of general principals and design of secure systems.

15. **Power System Fundamentals for Cyber Security Professionals (Power System 101) –** This course introduces foundational knowledge of the electric power system in layman's terms for people of all backgrounds. It includes some of the basic formulas, terminology, and equipment used in the power system industry and provides an overview of general design and operation of all sectors of the power system including generation, transmission, distribution, and energy utilization.
16. **Utilizing the Technical Assessment Methodology (TAM) to Support Defense in Depth -** This course introduces the foundational knowledge of the Technical Assessment Methodology for security practitioners of all backgrounds. It includes the basic concepts, process, and terminology used to perform the Technical Assessment Methodology and explores how this method can be used to help support a defense in depth strategy.

Information and Communications Technologies Course Topics

17. **A Grid Operator's Reference Guide on Communication Standards and Practices:** This course provides in-depth information on the use of proprietary and standards-based communication technologies for distributed energy resources including demand response, energy storage systems, distributed generation, and electric vehicles. In addition to an overview of different standards, a maturity assessment framework for these standards that an electric utility must consider before deploying DER systems would be explored including metrics such as regulatory needs, compliancy, market deployments, standards adoption, etc., models.
18. **Fundamentals of Information and Communication Technology for Distributed Energy Resources –** This course trains participants on the fundamentals communication protocols and models available for exchanging data, monitoring, and managing distributed energy resources (DER). This course will provide background information on DER, communication technologies, and half-a-dozen data protocols (each with a unique purpose) available for communicating with DERs over a diversity of grid networks. It will also introduce participations to information models which define the format and meaning of data transported over these protocols, provide example applications of deployment these protocols and data models for interoperability, and summarize the trajectory of adoption of these technologies in the smart grid.
19. **Information and Communication Technologies for Demand-Responsive Loads –** This course will provide in-depth information on the information and communication technologies used to design and end-to-end automation system for electric utility demand response programs. The technologies include communication protocols and systems available to leverage demand from customer-side resources, including system architecture, market actors, grid codes, and vendor technologies**.** The course will include a primer on interoperability practices that support electric utility program needs. In addition, example applications of deployment of these protocols and data types for related data analytics, as they apply for measurement and verification purposes will be explored.
20. **Information and Communication Technologies for Solar PV and Energy Storage -** This course will provide in-depth information on the information and communication technologies for smart inverter-based distributed energy resources which support end-to-end automation systems for interoperability and interconnection. The technologies include communication protocols and systems available to monitor and control of solar photovoltaic (PV) and energy storage systems, including system architecture, market actors, grid codes, and available vendor technologies. The course will also include primer on grid interconnection and interoperability practices that support electric utility program needs.
21. **Telecommunications Technologies for Data, Metering, and Analytics -** This course focuses on the fundamentals of telecommunication technology options such as Wi-Fi, powerline carrier, radio, 5G, etc., among other technology choices. Telecommunication system interface designs based on platform approaches will also be explored. Modern metering methods, communications, and products will be examined as the needs for metering technique, end-use metering, and other practices are evolving. Other advanced telecommunication-centric automation practices for distributed energy

resources (DER), advanced metering Interface (AMI), related standards will be considered. Data formats and structures for transporting data over various telecommunication networks will be evaluated to determine suitability and best practices will be provided. Size and frequency of information packets will be examined and Field Area Network (FAN) guidelines will be provided.

22. **The IEC Common Information Models (CIM) and IEC 61850 for Utility Enterprise Systems and Distribution Systems -** This course trains participants with in-depth understanding of the use of International Electrotechnical Commission's (IEC) Common Information Model (CIM) suite of standards, including the IEC 61850 standard for enterprise and distribution systems integration. The enterprise systems that are used by the electric utilities including enterprise architecture will be covered. The information models for CIM and 61850 and primers will be described, as they apply to electric utility and distribution system assets. The CIM-based network model management overview and techniques will also be provided.

Integration of Distributed Energy Resources Course Topics

23. **Applications of Smart Inverter Technology --** This course investigates the core theory, modeling and analysis behind smart inverter technology, and its application on the power system. Students will learn relevant characteristics of inverter operation, including topologies, modulation, maximum power point tracking, grounding, and protection. From the foundational understanding, "smart" functionality will be discussed including control of real and reactive power and low-voltage ride-through. Advanced methods of control such as frequency-Watt and Volt-VAR control will also be covered.
24. **DER Interconnection Processes and Screening –** This course will review different business practices and interconnection processes being employed by electric utilities. Different screening automated and manual criteria to aid in fast tracking interconnection applications, including the rationales behind each screen will be explored. The rationales, features, and functionalities of online interconnection portals will also be explored.
25. **DG Interconnection on Distribution Systems** -- This course provides computational examples that cover key issues that arise when distributed generation is added to radial distribution systems. Key topics include Voltage rise/drop; Voltage regulation; Fault performance and protection; Grounding and Temporary Overvoltage. This course includes material on Smart Inverter capability and adaptive time overcurrent protection in addition to the traditional methods for identifying DG penetration level limitations. It includes three design case studies as well as a series of on-line quizzes.
26. **Distributed Energy Resource Management Systems (DERMS) –** It becomes increasingly necessary to monitor and manage DER to maintain grid efficiency, reliability and power quality as quantities of grid-connected DER increase. This course provides an overview and foundational understanding of DER Management Systems (DERMS) which are the communication and control systems that serve this function. It will give students insight into the evolving functionality, uses cases, control hierarchies, performance, interfaces and integration of DERMS with overall distribution operations.
27. **Distribution System Modeling and Simulation for Distributed Energy Resources –** This course is intended to provide insight about some of the leading practices used by electric utilities for modeling and simulating distributed energy resources using both commercial and research software. The course will review different methods for performing hosting capacity studies, interconnection studies, and preparing data to conduct analysis.
28. **Electric Transportation –** This course develops the fundamentals of various electric transportation products and systems for moving people and materials. The properties of electric transport vehicles as in passenger cars, trucks, lift trucks, utility vehicles, vans, and commercial and industrial vehicles will be characterized. Attention will also be directed at infrastructure requirements for charging

vehicles with both conventional and fast charge options. Finally, utility impacts of all types of electric vehicles will be considered as well possible innovative electric rate structures for charging electric vehicles.

29. **Energy Storage Technologies, Applications, and Integration --** This course focuses on distributed energy storage technologies and applications. The operation and applications of energy storage and battery technologies for utility applications will be explored. The course content spans not only how these technologies work but also the history of their development and use and the benefits that distributed energy storage can bring to generation requirements; transmission and distribution systems; microgrids; and off-grid applications. Students will also learn about the policy, cost, and technical challenges facing the wider use of electricity storage and what can be done to address those challenges.
30. **IEEE Standard 1547 –** This course gives an overview on IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces (IEEE Std 1547-2018). It will help students understand the scope, limitations, and key revisions of DER interconnection performance and functional capability requirements. With regard to the utilization of advanced DER functions, a potential hierarchy and process for determining functional settings is discussed.
31. **Micro-Grid Concepts and Designs –** This course will examine and evaluate the principles and practices of microgrids. In particular, consideration will be given to renewable energy generation and its role in the microgrid. The principles of load/generation balance will be explored. The course will explore value proposition for applications such as military bases, eager to increase local reliability and decrease reliance on local grids especially with an emphasis on the use of renewable energy sources such as photovoltaic (PV) panels and small wind turbines, moderated by energy storage and fossil distributed generation. Various microgrid control strategies will be discussed and evaluated.
32. **Utility Applications of Power Electronics –** The fundamentals of power semiconductor devices and types are presented. In addition, building blocks for power electronic circuits are developed. The course flows by examining fundamental properties of various power electronic devices that are used in electric power systems. This includes such systems as grid tied power electronic converters, stationary energy storage interface, uninterruptible power supplies, power factor correction, active rectifiers, flexible AC transmission systems, and high voltage DC transmission.