| Day One | | | |
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| **Time** | **Topics** | **Instructor** | **Reading** |
| 9-10:30 | Introduction to bioprocess data analytics: opportunities, bioprocess data types including Raman, hyperspectral imaging, and LC-MS, types of data applications; taxonomy of data analytics and machine learning methods, course overview | Braatz | Lecture notes |
| 10:30-11 | Break | | |
| 11-12:30 | Regression: least squares, response surface methodology, ridge regression, lasso, elastic net, cross-validation, model accuracy quantification, feature engineering, nonlinearities, monoclonal antibody (mAb) manufacturing industrial case study | Braatz | Lecture notes |
| 12:30-2 | Lunch and networking | | |
| 2-4 pm | Tour of Continuous mAb, Gene Therapy, and mRNA Manufacturing Laboratories | Braatz | Lecture notes |
| 4-4:30 | Break | | |
| 4:30-5:30 | Networking and discussions | | |

| Day Two | | | |
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| **Time** | **Topics** | **Instructor** | **Reading** |
| 9-10:30 | Latent variable methods I: PCA, multivariable statistical process control, spectral sensor calibration, PCR, PLS, spectral data artifacts, Raman spectroscopy case study | Yoon | Lecture notes |
| 10:30-11 | Break | | |
| 11-12:30 | Latent variable methods II: CCA, FDA, missing data, sparse models, Raman and near-infrared case studies | Yoon | Lecture notes |
| 12:30-2 | Lunch and networking | | |
| 2-4 pm | Visualization and analysis of real biopharmaceutical process data | Yoon | Lecture notes |
| 4-4:30 | Break | | |
| 4:30-5:30 | Networking and discussions | | |

| Day Three | | | |
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| **Time** | **Topics** | **Instructor** | **Reading** |
| 9-10:30 | Tips and traps: Google Flu Trends, correlation vs. causation, misuse of matching statistics, effects of feedback loops, false correlations in microarray data, artifact removal during data preprocessing, assessing features for reasonableness | Braatz | Lecture notes |
| 10:30-11 | Break | | |
| 11-12:30 | Data analytics/machine learning method selection, automated machine learning, the pitfall of selecting from many models/methods by cross-validation, data interrogation, algebraic learning, industrial application to monoclonal antibody manufacturing | Braatz | Lecture notes |
| 12:30-2 | Lunch and networking | | |

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| 2-4 pm | Big data analytics: real-time video, thermal imaging, tensor data, hyperspectral imaging, LC-MS, multiway methods, multilinear subspace learning, lyophilization case studies, application to modeling batch-to-batch correlations | Braatz | Lecture notes |
| 4-4:30 | Break | | |
| 4:30-5:30 | Networking and discussions | | |

| **Day Four** | | | |
|---|---|---|---|
| **Time** | **Topics** | **Instructor** | **Reading** |
| 9-10:30 | Nonlinear analytics I: support vector machines; random forests; comparisons to FDA and k-nearest neighbor classification; feature engineering revisited; kernel methods; hybrid models; autoassociative & recursive neural networks | Anthony | Lecture notes |
| 10:30-11 | Break | | |
| 11-12:30 | Nonlinear analytics II: support vector machines; random forests; comparisons to FDA and k-nearest neighbor classification; feature engineering revisited; kernel methods; hybrid models; autoassociative & recursive neural networks | Anthony | Lecture notes |
| 12:30-2 | Lunch and networking | | |
| 2-4 pm | What can bioprocess analytics learn from other industries? | Anthony | Lecture notes |
| 4-4:30 | Break | | |
| 4:30-5:30 | Broader discussions and closing | Braatz / Anthony | |