BME Student/Faculty Guide for Course Selection (Machine Learning content)
Below is a list of courses (Engineering and Computer Science) that have Machine Learning (ML) content. In some cases, there is overlap of content, so BME students and faculty should use this document a guide for selecting (and approving) courses for Plans of Study.

ENGR:3110 (Changes Spring 2025) (ENGR:2995 through Fall 2024) -- Intro to AI & Machine Learning in Engineering

Catalog: Introduction to artificial intelligence (AI), machine learning, data science, and data driven problem solving across all engineering disciplines; topics include supervised and unsupervised learning, clustering, heuristics, feature selection, ethics of AI—fairness and privacy issues, and performance evaluation; first in a series.
Recommendation: This is an introductory level Machine Learning (ML) course offered by College of Engineering (COE). If you have taken any other COE ML course, you cannot take this course due to "regression." This course can be taken as an elective towards the BME degree requirements. Bioimaging and Computational Bioengineering focus area students can take this course instead of Thermodynamics as a required Engineering course. If you take this course in place of Thermodynamics, however, it cannot count as a replacement for Thermodynamics AND an elective (you will need an additional elective instead of ENGR:2995/ENGR:3110). Note, Thermodynamics can also be taken as an elective if ENGR:2995/ENGR:3110 is taken as a required Engineering course.
Recommendation: Can be taken as elective, OR as replacement for Thermodynamics (if you are Bioimaging or Computational Bioengineering).

BME:5240 Deep Learning in Medical Imaging

Prereqs: ENGR:2995, programming knowledge
Recommended: ECE:5480
Catalog: Advancements in artificial intelligence, specifically deep learning, have led to major breakthroughs in automated medical image analysis in recent years. The course will cover deep learning architectures successful in medical imaging including convolutional neural networks, auto-encoders, generative adversarial networks, and transformers. Students will become equipped with important tools and tricks to solve challenging medical imaging problems using deep learning including image diagnosis, detection, segmentation, registration, and synthesis. Course will be hands-on with training deep networks using GPU acceleration on real-world medical imaging problems with extensive use of Python and libraries including PyTorch, MONAI, SimpleITK, NumPy, and Matplotlib.
Recommendation: Can be taken as elective.

ECE:5450 / IGPI:5450 Machine Learning

Catalog: Prereqs: ECE:2400 or BME:2200
Fundamentals of machine learning theory including regression, classification, neural networks, clustering, and principal component analysis; engineering applications.
Recommendation: This course is the next course to take in sequence after ENGR:2995 and can be taken as an elective.

ECE:5455 Stat Found Inference & Machine Learning

Catalog: Prereqs: STAT:2020 and ECE:2400
Basic strategies to cope with noise in measurements with three objectives at core of most machine learning tasks—hypothesis testing (where one must choose between various hypotheses), parameter estimation (where multiple parameters whose values define how a system will behave must be estimated from noisy measurements), and filtering (where a noisy music signal must be cleaned up); topics include probability and statistics, random variables and signals, hypothesis testing, parameter estimation, discrete- and continuous-time random processes, and optimal filtering; assignments, written exams, and projects.
Recommendation: This course can be taken as an elective.

ECE:5995 Contemp Topics in Elect & Computer Eng (Generative AI tools: ChatGPT and Beyond)

Catalog: New topics or areas of study not offered in other electrical and computer engineering courses; based on faculty/student interest; not available for individual study.
Generative artificial intelligence (AI) tools are rapidly changing how people work, learn, create, and entertain. Within less than a year, for example, services like ChatGPT have already significantly impacted many industries, prompting important conversations about how such technologies should be adopted within society. This applied, project-based course offers a hands-on exploration of various generative AI tools such as large language models

(ChatGPT, Bard, LLaMA); image generators (Midjourney, DALL-E, Stable Diffusion); technologies for video, speech, music synthesis; neural radiance fields (NeRFs); and more. In-class labs, homework assignments, and projects will teach and allow students to use and combine these tools within a variety of domains, from solving engineering problems (e.g., test-driven software development) to creating mixed media artworks. The course will also actively discuss the critical ethical and legal implications of generative AI technologies, particularly as it relates to bias, privacy, and their broader impacts to society.
Recommendation: This course can be taken as an elective.

ECE:5995 Contemp Topics in Elect & Computer Eng (Applied Machine Learning)
Required: ECE:2400 or BME:2200
Description: New topics or areas of study not offered in other electrical and computer engineering courses; based on faculty/student interest; not available for individual study.
Catalog: Introduction to Deep Learning: Convolutional Neural Networks, Back-propagation, Optimization, Supervised training of classifiers and regression models, Representation theory. Designing and implement algorithms in PyTorch: Tips and tricks, Normalization approaches. Gain an in-depth understanding of machine learning theory & algorithms: Brief overview of support vector regression and classification, Kernel methods and links to deep learning. Introduction to unsupervised machine learning: Principal component analysis, Clustering, Auto-encoders, Generative adversarial networks.
Recommendation: This course can be taken as an elective.

Cross-listed:
CEE:4511 Scientific Computing and Machine Learning
ME:4111 Scientific Computing and Machine Learning
Catalog: Numerical methods in scientific computing; root problems and optimization; linear algebraic equations; eigenvalue problems; numerical differentiation and integration; interpolation and curve-fitting; initial value and boundary value problems; machine learning in regression, classification, and clustering problems; Python programming and packages.
Description: The objective of the course is to introduce scientific computing and machine learning methods that are commonly used in science and engineering computations. The emphasis will be on developing an understanding of appropriate scientific computing algorithms and machine learning models, and mastering problem-solving skills using numerical methods and machine learning software packages. All algorithms will be implemented in Python. Appropriate Python programming skills will be developed in the first few lectures. This course will cover the following major topics: solution of root and optimization problems, solution of systems of linear and nonlinear equations, numerical differentiation and integration, data science process via machine learning, solution of ordinary and partial differential equations.
Recommendation: These two courses have overlapping content with each other. These two courses do NOT overlap content with ECE:5450 Machine Learning. Only ONE of the two course can be taken as an elective towards the BME degree requirements.

ME:4150 Artificial Intelligence in Engineering
Catalog: Prereq: ME:4111
Artificial intelligence, computational intelligence, data science and engineering, machine intelligence, digital manufacturing and design, intelligent machining, fault diagnosis, autonomy, robotics; applications in mechanical engineering.
Recommendation: Can be taken as an elective.

BAIS:6480 Knowledge Discovery
BME students cannot take this course as an elective, they should take ENGR:2995 instead.
The course is intended for graduate students in BAIS only.

CS:5430 Machine Learning
This course overlaps with ECE:5450 Machine Learning. Engineering students should take ECE:5450.
Recommendation: This course is RESTRICTED to only CS graduate students, so engineering students cannot register for this course. The course has also not been offered in the last 2 years.

CS:4420 Artificial Intelligence

Catalog: Prereq: CS:3330

Introduction to artificial intelligence covering problem-solving methods, heuristic search, knowledge representation, automated reasoning, planning, game playing, machine learning, and neural networks.

Description:

The overall goal of this course is to introduce students to a number of topics and techniques in Artificial Intelligence (AI). Students should be prepared to put in considerable time and effort into reading to become familiar with these topics, and into programming to gain experience with these techniques. At the end of the semester, students should have the knowledge required to identify areas they would like to investigate in more depth in related courses. This knowledge includes: an introduction to the basic assumptions behind artificial intelligence problem solving; exposure to a broad range of AI topics; practice translating artificial intelligence concepts into working programs; a basic tool-kit of AI algorithms, techniques and representation methods that can be applied to a wide variety of problems.

Recommendation: Restricted for CS and CS&E students. ENGR:2995 (which will become ENGR:3110) sequence recommended instead.

CBE:5120 Data Science in Chem & Engr Systems

Catalog: Theory and application of numerical methods and data driven algorithms towards understanding chemical processes; scientific computing in Python programming language; numerical solutions to differential equations; nonlinear and constrained optimization; data preprocessing and visualization; dimensionality reduction and clustering; supervised machine learning.

Recommendation: Can be taken as an elective.

BIOC:3310 / CBIO:3310/ MMED:3310 Practical Data Science & Bioinformatics

This course is intended for students with NO computational background and is also intended for students in life-science programs/departments.   This course cannot be taken as an elective towards the BME degree requirements.

BIOS:6720:0001 Machine Learning for Biomedical Data

This course is currently restricted to BIOS majors, so it cannot be taken by COE students. There also appears to be overlap with ENGR:2995/ENGR:3110