

SEAS ENGINEERING (EUNG)

Code	Title	Course Units
BE 1000	Introduction to Bioengineering	0.5
BE 2000	Introduction to Biomechanics	1
BE 2200	Biomaterials	1
BE 3010	Bioengineering Signals and Systems	1
BE 3060	Cellular Engineering	1
BE 3090	Bioengineering Modeling, Analysis and Design Laboratory I	1
BE 3100	Bioengineering Modeling, Analysis and Design Laboratory II	1
BE 3300	Self-Assembly of Soft Materials	1
BE 3500	Introduction to Biotransport Processes	1
BE 4000	Preceptorship in Clinical Bioengineering	1
BE 4700	Medical Devices	1
BE 4720	Medical Device Development	1
BE 4800	Introduction to Biomedical Imaging	1
BE 4830	Physics of Medical/Molecular Imaging	1
BE 4900	Independent Project in Bioengineering	1
BE 4920	Independent Project in Bioengineering	1
BE 4950	Senior Design Project	1
BE 4960	Senior Design Project	1
BE 4970	Senior Thesis in Biomedical Science	1
BE 5020	From Biomedical Science to the Marketplace	1
BE 5040	Biological Data Science II: Data Mining Principles for Epigenomics	1
BE 5100	Biomechanics and Biotransport	1
BE 5120	Bioengineering III: Biomaterials	1
BE 5130	Human Centered Design for Clinical Emergency Medicine	1
BE 5140	Rehab Engineering and Design	1
BE 5180	Optical Microscopy	1
BE 5210	Brain-Computer Interfaces	1
BE 5280	Applied Medical Innovation I	1
BE 5290	Applied Medical Innovation II	1
BE 5370	Biomedical Image Analysis	1
BE 5400	Principles of Molecular and Cellular Bioengineering	1
BE 5470	Fundamental Techniques of Imaging	1
BE 5500	Continuum Tissue Mechanics	1
BE 5510	Biomicrofluidics	1
BE 5530	Principles, Methods, and Applications of Tissue Engineering	1
BE 5550	Nanoscale Systems Biology	1
BE 5580	Principles of Biological Fabrication	1
BE 5590	Multiscale Modeling of Chemical and Biological Systems	1
BE 5610	Musculoskeletal Biology and Bioengineering	1
BE 5620	Drug Discovery and Development	1
BE 5650	Developmental Engineering of Tissues	1
BE 5660	Networked Neuroscience	1
BE 5690	Systems Biology of Cell Signaling Behavior	1
BE 5700	Biomechatronics	1
BE 5760	The Cell as a Machine	1
BE 5810	Techniques of Magnetic Resonance Imaging	1
BE 5830	Physics of Medical / Molecular Imaging	1
BE 5850	Materials for Bioelectronics	1
BIOM 5350	Introduction to Bioinformatics	1
CBE 1500	Introduction to Biotechnology	1
CBE 1600	Introduction to Chemical Engineering	1
CBE 2300	Material and Energy Balances of Chemical Processes	1
CBE 2310	Thermodynamics of Fluids	1
CBE 3200	Basic Chemical Process Safety	1
CBE 3300A	Discover, Design, Build and Test: A Hands-On Introduction to Product and Device Design	0-0.5
CBE 3300B	Discover, Design, Build and Test: A Hands-On Introduction to Product and Device Design	0-0.5
CBE 3500	Fluid Mechanics	1
CBE 3510	Heat and Mass Transport	1
CBE 3530	Molecular Thermodynamics and Chemical Kinetics	1
CBE 3600	Chemical Process Control	1
CBE 3710	Separation Processes	1
CBE 3750	Engineering and the Environment	1
CBE 4000	Introduction to Product and Process Design	1
CBE 4100	Chemical Engineering Laboratory	1
CBE 4215	Energy and Sustainability: Science, Engineering and Technology	1
CBE 4300	Introduction to Polymers	1
CBE 4470	Societally Significant Soft Matter Solutions	1
CBE 4510	Chemical Reactor Design	1
CBE 4590	Product and Process Design Projects	1
CBE 4790	Biotechnology and Biochemical Engineering	1
CBE 4800	Laboratory in Biotechnology and Biochemical Engineering	1
CBE 5000	Special Topics in Chemical and Biomolecular Engineering	1
CBE 5020	Sustainability of Materials	1
CBE 5050	Carbon Capture	1
CBE 5080	Probability and Statistics for Biotechnology	1
CBE 5100	Introduction to Polymers	1
CBE 5140	Data Science and Machine Learning in Chemical Engineering	1
CBE 5170	Principles of Genome Engineering	1
CBE 5215	Energy and Sustainability: Science, Engineering and Technology	1
CBE 5220	Polymer Rheology and Processing	1

CBE 5250	Molecular Modeling and Simulations	1	CIS 2620	Automata, Computability, and Complexity	1
CBE 5270	Advancements and Applications in Genome Editing and Engineering	1	CIS 3200	Introduction to Algorithms	1
CBE 5300	Electrochemistry Fundamentals, Practices, and Analysis	1	CIS 3340	Advanced Topics in Algorithms	1
CBE 5310	Nano-Transport	1	CIS 3500	Software Design/Engineering	1
CBE 5350	Interfacial Phenomena	1	CIS 3900	Robotics: Planning Perception	1
CBE 5400	Principles of Molecular and Cellular Bioengineering	1	CIS 3980	Quantum Computer and Information Science	1
CBE 5450	Electrochemical Energy Conversion and Storage	1	CIS 3990	Special Topics	0-1
CBE 5460	Fundamentals of Industrial Catalytic Processes	1	CIS 4000	Senior Project	1
CBE 5470	Societally Significant Soft Matter Solutions	1	CIS 4010	Senior Project	1
CBE 5520	Protein Engineering & Practical Applications	1	CIS 4100	CIS Senior Thesis	1
CBE 5540	Engineering Biotechnology	1	CIS 4110	CIS Senior Thesis	1
CBE 5550	Nanoscale Systems Biology	1	CIS 4120	Introduction to Human Computer Interaction	1
CBE 5560	The Biochemical Engineering of Wine	1	CIS 4190	Applied Machine Learning	1
CBE 5570	Stem Cells, Proteomics and Drug Delivery - Soft Matter Fundamentals	1	CIS 4210	Artificial Intelligence	1
CBE 5590	Multiscale Modeling of Chemical and Biological Systems	1	CIS 4270	Trustworthy Machine Learning	1
CBE 5600	Water Treatment Engineering	1	CIS 4300	Natural Language Processing	1
CBE 5620	Drug Discovery and Development	1	CIS 4410	Embedded Software for Life-Critical Applications	1
CBE 5640	Drug Delivery Systems: Targeted Therapeutics and Translational Nanomedicine	1	CIS 4480	Operating Systems Design and Implementation	1
CBE 5800	Masters Biotechnology Lab	1	CIS 4500	Database and Information Systems	1
CBE 5801	Laboratory in Biotechnology and Biochemical Engineering	1	CIS 4510	Computer and Network Security	1
CIS 0099	Undergraduate Research/Independent Study	1	CIS 4520	Advanced Programming	1
CIS 1100	Introduction to Computer Programming	1	CIS 4521	Compilers and Interpreters	1
CIS 1200	Programming Languages and Techniques I	1	CIS 4550	Internet and Web Systems	1
CIS 1210	Programming Languages and Techniques II	1	CIS 4600	Interactive Computer Graphics	1
CIS 1810	The Quantum and the Computer	1	CIS 4610	Advanced Rendering	1
CIS 1901	C++ Programming	0-0.5	CIS 4620	Computer Animation	1
CIS 1902	Python Programming	0-0.5	CIS 4710	Computer Organization and Design	1
CIS 1903	Go Programming	0-0.5	CIS 4810	Computer Vision & Computational Photography	1
CIS 1904	Introduction to Haskell Programming	0-0.5	CIS 4970	DMD Senior Project	1
CIS 1905	Rust Programming	0-0.5	CIS 4980	Senior Capstone Project	1
CIS 1911	Using and Understanding Unix and Linux	0-0.5	CIS 5000	Software Foundations	1
CIS 1912	DevOps	0-0.5	CIS 5010	Computer Architecture	1
CIS 1921	Solving Hard Problems in Practice	0-0.5	CIS 5020	Analysis of Algorithms	1
CIS 1951	iOS Programming	0-0.5	CIS 5030	Algorithms for Big Data	1
CIS 1952	Android Programming	0-0.5	CIS 5050	Software Systems	1
CIS 1953	3D Game Development in Unreal Engine	0-0.5	CIS 5110	Theory of Computation	1
CIS 1961	Ruby on Rails Web Development	0-0.5	CIS 5120	Introduction to Human Computer Interaction	1
CIS 1962	JavaScript Programming	0-0.5	CIS 5150	Fundamentals of Linear Algebra and Optimization	1
CIS 1990	Special Topics	0-0.5	CIS 5180	Topics in Logic: Finite Model Theory and Descriptive Complexity	1
CIS 2330	Introduction to Blockchain	1	CIS 5190	Applied Machine Learning	1
CIS 2400	Introduction to Computer Systems	1	CIS 5200	Machine Learning	1
CIS 2450	Big Data Analytics	1	CIS 5210	Artificial Intelligence	1
			CIS 5220	Deep Learning for Data Science	1
			CIS 5260	Machine Translation	1
			CIS 5270	Trustworthy Machine Learning	1

CIS 5300	Natural Language Processing	1	ENGR 4215	Energy and Sustainability: Science, Engineering and Technology	1
CIS 5350	Introduction to Bioinformatics	1	ENGR 4500	Modern Biotechnology for Engineers	1
CIS 5370	Biomedical Image Analysis	1	ENGR 5030	Engineering in Oil, Gas and Coal, from Production to End Use	1
CIS 5400	Principles of Embedded Computation	1	ENGR 5040	Fundamental Concepts in Nanotechnology	1
CIS 5410	Embedded Software for Life-Critical Applications	1	ENGR 5215	Energy and Sustainability: Science, Engineering and Technology	1
CIS 5420	Embedded Systems Programming	1	ENGR 5400	Engineering Economics	1
CIS 5450	Big Data Analytics	1	ENGR 5500	Modern Biotechnology for Engineers	1
CIS 5480	Operating Systems Design and Implementation	1	ESE 1110	Atoms, Bits, Circuits and Systems	1
CIS 5490	Wireless Communications for Mobile Networks and Internet of Things	1	ESE 1500	Digital Audio Basics	1
CIS 5500	Database and Information Systems	1	ESE 1900	Silicon Garage: Introduction to Open Source Hardware and Software Platforms	0.5
CIS 5510	Computer and Network Security	1	ESE 2000	Artificial Intelligence Lab: Data, Systems, and Decisions	1
CIS 5520	Advanced Programming	1	ESE 2040	Decision Models	1
CIS 5521	Compilers and Interpreters	1	ESE 2100	Introduction to Dynamic Systems	1
CIS 5530	Networked Systems	1	ESE 2150	Electrical Circuits and Systems	1.5
CIS 5550	Internet and Web Systems	1	ESE 2180	Electronic, Photonic, and Electromechanical Devices	1.5
CIS 5560	Cryptography	1	ESE 2240	Signal and Information Processing	1.5
CIS 5570	Programming for the Web	1	ESE 2900	Introduction to Electrical and Systems Engineering Research Methodology	0.5
CIS 5590	Programming and Problem Solving	1	ESE 2910	Introduction to Electrical and Systems Engineering Research and Design	1
CIS 5600	Interactive Computer Graphics	1	ESE 2920	Invention Studio	0.5
CIS 5610	Advanced Computer Graphics	1	ESE 3030	Stochastic Systems Analysis and Simulation	1
CIS 5620	Computer Animation	1	ESE 3040	Introduction to Optimization	1
CIS 5630	Physically Based Animation	1	ESE 3050	Foundations of Data Science	1
CIS 5640	Game Design and Development	1	ESE 3060	Deep Learning: A Hands-on Introduction	1
CIS 5650	GPU Programming and Architecture	1	ESE 3190	Fundamentals of Solid-State Circuits	1.5
CIS 5660	Procedural Computer Graphics	1	ESE 3200	Qubit Lab – A Hands on Introduction to Quantum Devices	1.5
CIS 5680	Game Design Practicum	1	ESE 3250	Fourier Analysis and Applications in Engineering, Mathematics, and the Sciences	1
CIS 5710	Computer Organization and Design	1	ESE 3360	Nanofabrication of Electrical Devices	1.5
CIS 5730	Software Engineering	1	ESE 3400	Medical Devices Laboratory	1
CIS 5800	Machine Perception	1	ESE 3500	Embedded Systems/Microcontroller Laboratory	1.5
CIS 5810	Computer Vision & Computational Photography	1	ESE 3600	TinyML: Tiny Machine Learning for Embedded Systems	1
CIS 6200	Advanced Topics in Machine Learning	1	ESE 3990	Special Topics	1
CPLN 6500	Transportation Planning Methods	1	ESE 4000	Engineering Economics	1
CPLN 7500	Advanced Transportation Seminar	1	ESE 4040	Engineering Markets	1
ENGR 1010	Introduction to Engineering: Energy, Environment and Sustainability	1	ESE 4070	Introduction to Networks and Protocols	1
ENGR 1050	Introduction to Scientific Computing	1	ESE 4190	Analog Integrated Circuits	1
ENGR 1400	Penn Global Seminar: Robotics and Rehabilitation	1	ESE 4210	Control For Autonomous Robots	1.5
ENGR 2120	Concepts in Micro- and Nanotechnology	1	ESE 4380	Machine Learning for Time-Series Data	1
ENGR 2500	Energy Systems, Resources and Technology	1	ESE 5000	Linear Systems Theory	1
ENGR 3300A	Discover, Design, Build and Test: A Hands-On Introduction to Product and Device Design	0-0.5	ESE 5010	Networking - Theory and Fundamentals	1
ENGR 3300B	Discover, Design, Build and Test: A Hands-On Introduction to Product and Device Design	0-0.5	ESE 5030	Simulation Modeling and Analysis	1
ENGR 3440	Answering Questions with Data, for Everyone	1			

ESE 5050	Feedback Control Design and Analysis	1	IPD 5290	Designing Connected Objects and Experiences	1
ESE 5060	Introduction to Optimization Theory	1	IPD 5510	Design Processes	1
ESE 5070	Introduction to Networks and Protocols	1	IPD 5520	Problem Framing	1
ESE 5090	Quantum Circuits and Systems	1	IPD 5680	Integrative Design Studio: Biological Design	1
ESE 5100	Electromagnetic and Optics	1	IPD 5900	Special Topics in Integrated Product Design	0.5-1
ESE 5120	Dynamical Systems for Engineering and Biological Applications	1	MEAM 1010	Introduction to Mechanical Design	1
ESE 5140	Graph Neural Networks	1	MEAM 2010	Machine Design and Manufacturing	1
ESE 5190	Smart Devices	1	MEAM 2020	Introduction to Thermal-Fluids Engineering	1
ESE 5210	The Physics of Solid State Energy Devices	1	MEAM 2030	Thermodynamics I	1
ESE 5230	Quantum Engineering	1	MEAM 2100	Statics and Strength of Materials	1
ESE 5250	Nanoscale Science and Engineering	1	MEAM 2110	Engineering Mechanics: Dynamics	1
ESE 5280	Estimation and Detection Theory	1	MEAM 2200	Fundamentals of Materials Science and Engineering	1
ESE 5290	Introduction to Micro- and Nano-electromechanical Technologies	1	MEAM 2250	Engineering in the Environment	1
ESE 5300	Elements of Probability Theory	1	MEAM 2300	Bicycles: The Mechanical Advantage	1
ESE 5310	Digital Signal Processing	1	MEAM 2470	Mechanical Engineering Laboratory I	.5
ESE 5320	System-on-a-Chip Architecture	1	MEAM 2480	Mechanical Engineering Lab I	.5
ESE 5330	Stochastic Processes	1	MEAM 3020	Fluid Mechanics	1
ESE 5350	Electronic Design Automation	1	MEAM 3200	Intro to Mechanical and Mechatronic Systems	1
ESE 5390	Hardware/Software Co-Design for Machine Learning	1	MEAM 3210	Dynamic Systems and Control	1
ESE 5400	Engineering Economics	1	MEAM 3330	Heat and Mass Transfer	1
ESE 5430	Human Systems Engineering	1	MEAM 3470	Mechanical Engineering Design Laboratory	1
ESE 5450	Data Mining: Learning from Massive Datasets	1	MEAM 3480	Mechanical Engineering Design Laboratory	1
ESE 5460	Principles of Deep Learning	1	MEAM 3540	Mechanics of Solids	1
ESE 5470	Introduction to Legged Locomotion	1	MEAM 4050	Mechanical Properties of Macro/Nanoscale Materials	1
ESE 5480	Transportation Planning Methods	1	MEAM 4110	How to Make Things: Production Prototyping Studio	1
ESE 5500	Advanced Transportation Seminar	1	MEAM 4150	Product Design	1
ESE 5660	Networked Neuroscience	1	MEAM 4210	Control For Autonomous Robots	1.5
ESE 5700	Digital Integrated Circuits and VLSI-Fundamentals	1	MEAM 4450	Mechanical Engineering Design Projects	1
ESE 5720	Analog Integrated Circuits	1	MEAM 4460	Mechanical Engineering Design Projects	1
ESE 5730	Chips-design	1	MEAM 5020	Energy Engineering in Power Plants and Transportation Systems	1
ESE 5780	RFIC (Radio Frequency Integrated Circuit) Design	1	MEAM 5030	Direct Energy Conversion: from Macro to Nano	1
ESE 5800	Power Electronics	1	MEAM 5040	Tribology	1
ESE 6170	Non-Linear Control Theory	1	MEAM 5050	Mechanical Properties of Macro/Nanoscale Materials	1
ESE 6650	Datacenter Architecture	1	MEAM 5060	Failure Analysis of Engineering Materials	1
IPD 5000	Product Engineering Basics	1	MEAM 5080	Materials and Manufacturing for Mechanical Design	1
IPD 5010	Integrated Computer-Aided Design, Manufacturing and Analysis	1	MEAM 5100	Design of Mechatronic Systems	1
IPD 5030	Design Fundamentals	1	MEAM 5130	Feedback Control Design and Analysis	1
IPD 5040	Rehab Engineering and Design	1	MEAM 5140	Design for Manufacturability	1
IPD 5110	How to Make Things: Production Prototyping Studio	1	MEAM 5160	Advanced Mechatronic Reactive Spaces.	1
IPD 5140	Design for Manufacturability	1	MEAM 5170	Control and Optimization with Applications in Robotics	1
IPD 5150	Product Design	1	MEAM 5180	Biomedical Microsystems	1
IPD 5160	Advanced Mechatronic Reactive Spaces.	1	MEAM 5190	Elasticity and Micromechanics of Materials	1
IPD 5190	Smart Devices	1	MEAM 5200	Introduction to Robotics	1
IPD 5250	Ergonomics/Human Factors Based Product Design	1			

MEAM 5270	Finite Element Analysis	1	MSE 5180	Structure and Function of Biological Materials	1
MEAM 5290	Introduction to Micro- and Nano-electromechanical Technologies	1	MSE 5200	Structure of Materials	1
MEAM 5300	Continuum Mechanics	1	MSE 5250	Nanoscale Science and Engineering	1
MEAM 5350	Advanced Dynamics	1	MSE 5300	Thermodynamics and Phase Equilibria	1
MEAM 5360	Viscous Fluid Flow and Modern Applications	1	MSE 5360	Electronic Properties of Materials	1
MEAM 5370	Nanotribology	1	MSE 5370	Nanotribology	1
MEAM 5430	Performance, Stability and Control of UAVs	1	MSE 5380	Phase Transformations	1
MEAM 5450	Aerodynamics	1	MSE 5400	Kinetics of Materials	1
MEAM 5500	Design of Microelectromechanical Systems	1	MSE 5450	Materials for Energy and Environmental Sustainability	1
MEAM 5530	Atomic Modeling in Materials Science	1	MSE 5500	Elasticity and Micromechanics of Materials	1
MEAM 5550	Nanoscale Systems Biology	1	MSE 5550	Electrochemical Engineering of Materials	1
MEAM 5610	Thermodynamics: Foundations, Energy, Materials	1	MSE 5610	Atomic Modeling in Materials Science	1
MEAM 5620	Water Treatment Engineering	1	MSE 5650	Fabrication and Characterization of Micro and Nanostructured Materials	1
MEAM 5700	Transport Processes I	1	MSE 5700	Physics of Materials I	1
MEAM 5710	Advanced Topics in Transport Phenomena	1	MSE 5750	Statistical Mechanics	1
MEAM 5750	Micro and Nano Fluidics	1	MSE 5760	Machine Learning and Its Applications in Materials Science	1
MEAM 6130	Non-Linear Control Theory	1	MSE 5800	Introduction to Polymers	1
MPHY 6090	Biomedical Image Analysis	1	MSE 5850	Materials for Bioelectronics	1
MSE 1010	Introduction to Materials Science & Engineering	1	MTR 5350	Introduction to Bioinformatics	1
MSE 2010	Materials Lab I	.5	NETS 1120	Networked Life	1
MSE 2020	Materials Lab II	.5	NETS 1500	Market and Social Systems on the Internet	1
MSE 2150	Introduction to Functional Materials: From Macro to Nanoscale	1	NETS 2120	Scalable and Cloud Computing	1
MSE 2200	Fundamentals of Materials Science and Engineering	1	NETS 2130	Crowdsourcing and Human Computation	1
MSE 2600	Energetics of Macro and Nano-scale Materials	1	NETS 3120	Theory of Networks	1
MSE 3010	Materials Lab III	.5	NETS 4120	Algorithmic Game Theory	1
MSE 3300	Self-Assembly of Soft Materials	1	NGG 5210	Brain-Computer Interfaces	1
MSE 3600	Structure at the Nanoscale	1	OIDD 4110	How to Make Things: Production Prototyping Studio	1
MSE 3930	Materials Selection	1	OIDD 4150	Product Design	1
MSE 4050	Mechanical Properties of Macro/Nanoscale Materials	1	OIDD 5110	How to Make Things: Production Prototyping Studio	1
MSE 4280	Solid-State Materials Chemistry	1	OIDD 5150	Product Design	1
MSE 4300	Introduction to Polymers	1	PHRM 5640	Drug Delivery Systems: Targeted Therapeutics and Translational Nanomedicine	1
MSE 4400	Phase Transformations	1	SCMP 5590	Multiscale Modeling of Chemical and Biological Systems	1
MSE 4550	Electrochemical Engineering of Materials	1	VIPR 0120	Vagelos Integrated Program in Energy Research (VIPER) Seminar, Part I	0.5
MSE 4600	Computational Materials Science	1	VIPR 1210	Vagelos Integrated Program in Energy Research (VIPER) Seminar, Part II	0.5
MSE 4650	Fabrication and Characterization of Micro and Nanostructured Materials	1			
MSE 4950	Senior Design	1			
MSE 4960	Senior Design	1			
MSE 5000	Experimental Methods in Materials Science	1			
MSE 5020	Sustainability of Materials	1			
MSE 5050	Mechanical Properties of Macro/Nanoscale Materials	1			
MSE 5060	Failure Analysis of Engineering Materials	1			
MSE 5150	Mathematical Methods for Engineering Applications	1			