	Typically Offered				
	Sp	**Su**	**Fa**	**W**	**Prerequisites/ Enrollment Requirements**
ABE UNDERGRADUATE CLASSES					
ABE 120, Microcomputing Applications – Introduction to computer concepts, file management, and Microsoft windows operating systems. In addition students will be taught the use of Microsoft Word, Excel spreadsheets, and PowerPoint presentations for business applications. (3 units, Online)	✓		✓		
ABE 170A1, Basic Concepts in Water-related Applications – This course develops an understanding of natural science concepts and ideas and how they can be used to understand and analyze processes and objects in the every-day world. Water is a central theme. Students examine how it is obtained, stored, distributed, used, polluted, and cleaned. They learn to estimate its quality, quantity, energy, and movement. It is a broad introductory course. Available also as honors, study abroad, and student exchange credits. (3 units, Online)	✓	✓	✓		
ABE 170A2, Science, Technology, and Environment – The scientific method, technology, motion, energy, gases, heat, chemistry, electricity, and magnetism are covered in class lectures. In laboratories, students will use physical principles to assess environmental problems and technology: e.g., CAP water, air pollution, solar cookers, and water use in the arid southwest. Available also as study abroad and student exchange credits. (3 units, Hybrid)	✓	✓	✓		
ABE 193, Internship – Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment. (1-3 units)	✓	✓	✓	✓	
ABE 199, Independent Study – Qualified students working on an individual basis with professors who have agreed to supervise such work. (1-3 units)	✓	✓	✓	✓	
ABE 201, Introduction to Biosystems Engineering – This course provides an introduction biosystems engineering with emphasis on biological laboratory skills and basic fabrication, foundations of modeling biological processes, team work and professional skills, and the societal and global context in which the profession is practiced. Discussion topics include internship opportunities, professionalism, engineering ethics, and the impact of engineering on society. Laboratory exercises include renewable energy production, device design and fabrication, and biological sensing. Presentations, discussions, and writing exercises will provide communication experiences. (2 units)			✓		MATH 124
ABE 205, Engineering Analytic Computer Skills – Introduction to Excel, Visual Basic in Excel, Access, and Matlab with an emphasis on flow charts, graphing, regression, if-then, do loops, statistics, functions and subroutines, and copying to and reporting results in Word; applications include biological energy, growth, and CO2 models. (3 units, Hybrid)	✓	✓			College of Engineering majors only

ABE 220, Introduction to Computer Aided Design – Introduction to computer aided design concepts and techniques using AutoCAD. Two and three-dimensional drawing presentation, methods of graphical communications, data analysis, design synthesis and production methods. (3 units, Online) New for Spring 2018	✓	✓	✓		
ABE 221, Introduction to Computer Aided Design – Introduction to computer aided design concepts and techniques using Solid Works. Two and three-dimensional drawing presentation, methods of graphical communications, data analysis, design synthesis and production methods. (3 units, Online)	✓	✓	✓		
ABE 270, Introduction to Biosensors and Mobile Health – Several types of biosensors have become quite commercially successful in the past couple of decades, including glucose meters, pulse oximeters, and pregnancy tests. Recently, more advanced types of biosensors are being investigated and commercialized, to detect pathogens from food/water as well as animals/humans, to provide comprehensive blood test at home, etc. Major breakthroughs in achieving high sensitivity and specificity have been achieved with the use of lab-on-a-chip and nanotechnology. Towards easy-to-use, handheld, and daily monitoring of health conditions at home, use of Arduino, Raspberry Pi, 3D printing, smartphone, and other wearable devices are being investigated. Together with cloud computing, these efforts constitute a novel concept of mobile health or mHealth, which will revolutionize the future of health care. (3 units)		✓			
ABE 284, Biosystems Thermal Engineering – This course provides an integrated introduction to basic thermal engineering topics. A structured problem-solving approach emphasizes the interrelated roles of Thermodynamics, Fluid Mechanics, and Heat and Mass Transfer relevant to real-world engineering analyses. (3 units)			✓		MATH 129, PHYS 141
ABE 293, Introduction to Fabrication for Engineers – This course provides an integrated introduction to basic fabrication topics. An emphasis on the interrelated roles of precision measurement, materials selection and reading of technical drawings and specifications, to teach real-world engineering analyses of fabricated/manufactured objects, and the materials and processes used to make them. Students are presented with introductory skills and knowledge in fabrication, and will gain experience in handling and maintaining hand and power tools and equipment, basic fabrication methods, and safety in fabrication work place/environment. (1 unit)	✓		✓		
ABE 299, Independent Study – Qualified students working on an individual basis with professors who have agreed to supervise such work. Available also as honors credits. (1-3 units)	✓	✓	✓		

ABE 385, Precision Observation with Drones – Precision Observation with Drones is an introductory course about the practical aspects of small-scale multirotor unmanned aerial system with a strong emphasis on quadcopters. The course aims at introducing the students to the new and evolving field of small multirotor Unmanned Aerial Vehicles/Systems (UAV, UAS, Drones), their electrical and electronics subsystems, how they work, to size and build a small drone, add useful sensors, use the system for observing the physical and biological environment, and how to manage and process some of the most common data collected by drones. Upon completing this course, the student should become familiar with small drone technology, be able to understand their potentials and limitations, add different sensors, collect and analyze data with the drones. The course is aimed at all students with basic science and engineering knowledge and a desire to observe, remotely sense, and collect data about the natural environment with high precision. (3 units)			✓		
ABE 393, Internship – Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment. Available also as study abroad and student exchange credits. (1-3 units)	✓	✓	✓		Adv. Standing; Engineering major
ABE 397A, Teaching Workshop – see SWES 397A					
ABE 399, Independent Study – Qualified students working on an individual basis with professors who have agreed to supervise such work. Available also as honors, honors study abroad, and student exchange credits. (1-4 units)	✓	✓	✓		Adv. Standing; Engineering major
ABE 413, Applied Biostatistics – Introductory and advanced statistical methods and their applications in ecology. Focuses on how research design dictates choice of statistical models; explores principles and pitfalls of hypothesis testing. (3 units)			✓		
ABE 422, Open-Channel Flow – see CE 422					NOT OFFERED AT THIS TIME
ABE 423,* Biosystems Analysis and Design – Application of systems analysis to biologically-related problems; computer modeling and use of simulations, optimization methods, decision support systems. May be co-convened with ABE 523. (3 units)	✓				Adv. Standing; Engineering major; Familiarity with statistics
ABE 424, Applied Cyberinfrastructure Concepts – see ISTA 424			✓		
ABE 426,* Watershed Engineering – Design of waterways, erosion control structures and small dams. Methods for frequency analysis and synthetic time distribution of rainfall. Methods for estimating infiltration and runoff from small watersheds, flow routing and storm water management. Estimating erosion using the Revised Universal Soil Loss Equation. May be co-convened with ABE 526. (3 units)			✓		Adv. Standing; Engineering or WSM major or minor; CE 218 or AME 331
ABE 427, Computer Applications in Hydraulics – see CE 427					

ABE 428,* Control of Erosion Processes – According to the US environmental regulations, it is mandatory that everyone who disturbs the soil is responsible for the sediments generated from that site. For instance, knowledge of erosion/sediment processes and control is an important tool those days to avoid federal penalties. The course focuses on the types of soil erosion, factors affecting it, and how to estimate erosion rates. Also, the student will learn how to design erosion control practices, based on certain runoff. May be co-convened with ABE 528. (3 units)	✓		✓		Adv. Standing; Engineering major; MATH 124 or MATH 125
ABE 447,* Sensors and Controls – Principles of electric circuits. Selection, interfacing and calibration of digital and analog sensors to measure physical variables. Optical electrochemical and piezoelectric biosensors. Basic bioprocess control. May be co-convened with ABE 547. (3 units)			✓		Adv. Standing; Engineering major; CHEM 151 and CHEM 152 (or equivalent)
ABE 452,* Globalization, Sustainability, and Innovation – Globalization, sustainability and innovation constitute the three principal forces that drive the world of the 21st century -- economically, politically, socially and culturally. Aimed at engineering and science students, the objective of the course is to foster among them global intelligence (or global smarts), defined as an inclusive and cross-disciplinary working knowledge of how the globe operates today - including (1) how global infrastructures in communication, transportation and information technology have transformed how nations and corporations conduct business, (2) how nurturing sustainability ensures competitive advantage while ignoring it imperils nations as well as the planet, and (3) how technological innovation is critical both in maintaining competitive advantage and in providing the essential sustainable solutions to many of our current global challenges. In a flat world, fostering global intelligence has become a vital component of a well-rounded engineering and science education. May be co-convened with ABE 552. Available also as study abroad and student exchange credits. (3 units)	✓				Adv. Standing; Engineering major
ABE 455,* Soil and Water Resources Engineering - Introduction to soil and water relationships, irrigation systems, irrigation water supply, irrigation management, and basic designs. May be co-convened with ABE 555. (3 units)			✓		Adv. Standing; Engineering major; Junior or Senior status; CE 218 or AME 331
ABE 456,* Irrigation Systems Design – Design and operation of surface, sprinkler, and trickle irrigation systems based on economic and environmental criteria. May be co-convened with ABE 556. (3 units)	✓ Odd yrs				Adv. Standing; Engineering major; CE 218
ABE 458,* Soils, Wetlands, and Wastewater Reuse – Water quality and system design for agricultural drainage and waste-water systems. May be co-convened with ABE 558. (3 units)	✓ Even yrs				Adv. Standing; Engineering major; CE 218 or AME 331

ABE 459,* Design of Onsite Wastewater Treatment and Dispersal Systems – This course will cover issues and concepts relating to the design of domestic and small commercial onsite wastewater treatment and recycling systems. This course is typically offered every even spring semester. This course is typically offered every even spring semester. May be co-convened with ABE 559. (3 units, Online)	✓ Even yrs	✓			Adv. Standing; Engineering major; Junior or Senior status
ABE 467, Advanced Watershed Hydrology – see WSM 567					
ABE 475A, Physiology of Plant Production under Controlled Environment – see PLS 475A					
ABE 479,* Applied Instrumentation for Controlled Environment Agriculture – Students will learn principles, methods, and techniques related to the measurement and control of environmental factors affecting plant growth and plants' surrounding climate under controlled environments. Light intensity, light quality, temperature (air, plant), relative humidity, carbon dioxide, water, air current, and related factors are important variables in controlled environment plant production systems to measure and control since they affect and determine plant growth and development and processes such as heating, ventilating and air conditioning, fertigation etc. Therefore, students will learn application of sensors, instrumentation and designing of a simple system to measure and control environments for plant production systems. May be co-convened with ABE 579. (3 units)	✓ Even yrs				Adv. Standing; Engineering major OR PLS major or minor; Junior or Senior status; MATH 113 and PHYS 102
ABE 481A,* Engineering of Biological Processes – see CHEE 481A					
ABE 481B,* Cell and Tissue Engineering – Development of biological engineering methods including applied genetics, metabolic regulation, and bioreactors employed in industrial processes for manufacture of pharmaceuticals and in the design of tissue engineered devices to replace normal physiological function. May be co-convened with ABE 581B. (3 units)	✓				Adv. Standing; Engineering major; CHEM 151 and CHEM 152
ABE 482,* Integrated Engineered Solutions in the Food-Water-Energy Nexus – Integrated engineered solutions in the Food-Water-Energy Nexus are transformational integrated designs -- drivers of change -- that are necessary to make feeding an increased global population this century possible, environmentally sustainable, and cost-effective. May be co-convened with ABE 582. (3 units)			✓		Adv. Standing; Engineering major;
ABE 483,* Controlled Environment Systems – An introduction to the technical aspects of greenhouse design, environmental control, hydroponic crop production, plant nutrient delivery systems, intensive field production systems, and post-harvest handling and storage of crops. May be co-convened with ABE 583. (3 units)			✓		Adv. Standing; Engineering major or minor; PLS major; Junior or Senior status

ABE 485, Remote Sensing Data and Methods – This course provides an in depth overview of practical topics in land remote sensing with big data, data sourcing and provenance, characteristics, generating algorithms, data discovery, advanced analysis, and data limitations. Students will learn how to discover and acquire a variety of global to regional land remote sensing data, learn about the various sensors/platforms collecting these data, learn how to interpret and use these data emphasizing real-world applications and research topics. The course is aimed primarily at students of biosystems engineering, environmental sciences, and natural resources management, and aims at bridging the gap between the theoretical aspects of remote sensing and current Earth science data records, algorithms, and analytics.	✓				
ABE 486,* Biomaterial-Tissue Interactions – Biomaterials and their applications; protein-surface and blood-biomaterial interactions, inflammation, wound healing, biocompatibility, implants, and tissue engineering. May be co-convened with ABE 586. (3 units)	✓				Adv. Standing; Engineering major; CHEM 151 and CHEM 152
ABE 487,* Metagenomics: From Genes to Ecosystems – Environmental genomics is revolutionizing our understanding of microbes from the environment to human health, towards a holistic view of ecosystems or "One-Health". At its core are new molecular methods called metagenomics to sequence DNA directly from an environmental sample, thus capturing the whole microbial community and bypassing culture. Modern (Next-Gen) sequencing technologies offer vast new datasets of short sequence reads representing these microbial communities, however many hurdles exist in interpreting data with high species complexity and given specialized software for microbial metagenomic analyses. This course focuses on the science of metagenomics towards understanding (1) questions that metagenomics can address, (2) possible approaches for metagenomic sequencing and analysis, and (3) how genes, pathways, and environmental context are translated into ecosystem-level knowledge. This course alternates between traditional lectures and hands-on experience with programming, bioinformatics tools, and metagenomic analysis. The course concludes with several weeks of seminar-format discussions on current research in metagenomic data analysis and a final project of your choice analyzing real-world experimental data. May be co-convened with ABE 587. (3 units)			✓		College of Science Junior or Senior with 2.0 GPA or higher, or College of Agricultural and Life Sciences Junior or Senior status with 2.0 GPA or higher; MCB 416, ABE 201, MIC 205 are recommended
ABE 488, Micro and Nano Transducer Physics and Design – see AME 488.					
ABE 489A, Fabrication Techniques for Micro and Nano Devices – see AME 489A.					
ABE 489B, Bio Micro/Nanotechnology Applications – see AME 489B.	✓				CHEM 152 or MSE 110; Basic familiarity with cells, proteins, and DNA – NOT OFFERED AT THIS TIME

ABE 492, Directed Research – Student will participate a faculty-led research within the University of Arizona as an individual or as a small group. The faculty member will provide clear objectives at the beginning of the class, and meet with the student on a regular basis to track his/her progress. Towards the end of the class, the student needs to make oral presentation(s) in laboratory meeting and submit a written report to the faculty member. Department Consent is required. (1-3 units)	✓	✓	✓	✓	
ABE 493, Internship – Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment. (3-6 units)	✓	✓	✓	✓	Adv. Standing; Engineering major; Junior or Senior status
ABE 496A, Seminar in Engineering Careers and Professionalism – The seminar will focus on employment in agricultural and biosystems engineering and engineering professionalism. Topics will include how to find a job (finding opportunities, writing resumes, interviewing), continuing education (professional societies, schools, self-learning) and engineering ethics. Presentations and discussion will provide communication opportunities. Students will be required to registrar for the Fundamentals of Engineering Exam (FE). (1 unit)			✓		Adv. Standing; Engineering major; Junior or Senior status; Concurrent enrollment in ABE 498A
ABE 497C, Greenhouse Pest Management: Methods and Practice – see ENTO 497C					

ABE 498B, Senior Capstone: Biosystems Engineering Design II – A culminating experience for majors involving a substantive project that demonstrates a synthesis of learning accumulated in the major, including broadly comprehensive knowledge of the discipline and its methodologies. Available also as honors credit. (3 units)	✓				Adv. Standing; Engineering major; Senior status; ABE 498A; Students will be required to take the Fundamentals of Engineering Exam (FE)
ABE 499, Independent Study – Qualified students working on an individual basis with professors who have agreed to supervise such work. Available also as honors credit. (1-4 units)	✓	✓	✓	✓	
AME 488,* Micro and Nano Transducer Physics and Design – Principles, design, and performance of micro and nano transducers. Designing MEMS to be produced with both foundry and nonfoundry processes. Applications of unique properties of micro and nano transducers for biological and engineering problems. Associated signal processing requirements for these applications. May be co-convened with AME 588. (3 units)	✓				Adv. Standing; Engineering major or (Plant Sciences, Environmental Science, or Environmental and Resource Economics major with Junior or Senior status); AME 250 and (ECE 207 or ABE 447); AME/ABE 489/589 Recommended
AME 489A,* Fabrication Techniques for Micro and Nano Devices – This course tackles the techniques for the design, fabrication, and testing of traditional microelectromechanical systems (MEMS) and nanodevices. Each student will be required to participate in weekly laboratory sessions, to keep a laboratory notebook, and to submit a project report (25% Honors final grade;15% Undergraduate final grade) focusing on the design, fabrication, and testing of a MEMS device. Honors students receive additional homework assignments typically involving derivation or proof of a theory presented in class. Additionally, Honors students are asked to complete an independent MEMS/NEMS design, while undergraduates can use an existing device design. Grading differences are reflected in the syllabus. May be co-convened with AME 589A. (3 units)			✓		Adv. Standing; Engineering major or (Plant Sciences, Environmental Science, or Environmental and Resource Economics major with Junior or Senior status); ECE 207 or ABE 447; Completion of Laboratory Chemical Safety Course
AME 489A,* Bio Micro/Nanotechnology Applications – This course tackles the applications of modern micro/nano devices or systems including lab-on-a-chip, DNA/protein array, drug carriers and other therapeutic systems, neuroscience applications, and food/agricultural systems. Toward this end, three different topics will be covered in this class: (1) brief overview on modern micro- and nanofabrication technologies, (2) biophysics principles for analytes and its recognition, and (3) various sensing modalities specific to these systems. May be co-convened with ABE 589B. (3 units)					
CE 422,* Open-Channel Flow – [Usually offered every three semesters beginning Fall 2007] Differential equations governing unsteady flow in open channels. Simple surface waves in subcritical and supercritical flows. Introduction of kinematic, diffusion, and dynamic wave methods. Applications to reservoir routing, dam break flow, and overland flow. May be co-convened with CE 522. (3 units)	✓		✓		Adv. Standing; Engineering major; CE 323 or consent of instructor – NOT OFFERED AT THIS TIME

CE 427,* Computer Applications in Hydraulics – Computer modeling of surface water hydrology, flood plain hydraulics and water distribution systems. Theoretical basis. Application and design studies. May be co-convened with CE 527. (3 units)			✓		Adv. Standing; Engineering major; CE 323 or consent of instructor
CHEE 481A,* Engineering of Biological Processes – To learn to apply to the design of biological systems principles of engineering, science and mathematics, including, but not limited to statistics, kinetics, sensors and bioreactor design and scale up. To explore and be familiar with the principal areas of biological engineering such as food process engineering, tissue engineering, and other large-scale fermentation processes. May be co-convened with CHEE 581A. (3 units)			✓		Adv. Standing; Engineering major; MATH 254 and MCB 182 or MIC 205A or CHEE 450 or instructor consent.
ENTO 497C,* Greenhouse Pest Management: Methods and Practice – Pest management skills development in the Controlled Environment Agriculture Center (CEAC) teaching/research greenhouses, with hands-on assignments, and group discussion covering pest management principles, methods, and current practice. May be co-convened with ENTO 597C. (3 units)	✓				Adv. Standing; Engineering major or major/minor in AGTM, ENTO, PLS; Junior or Senior status; PLS 217
ISTA 424, Applied Cyberinfrastructure Concepts – Students will learn from experts from projects that have developed widely adopted foundational Cyberinfrastrcutrue resources, followed by hands-on laboratory exercises focused around those resources. Students will use these resources and gain practical experience from laboratory exercises for a final project using a data set and meeting requirements provided by domain scientists. Students will be provided access to computer resources at: UA campus clusters, iPlant Collaborative and at NSF XSEDE. Students will also learn to write a proposal for obtaining future allocation to large scale national resources through XSEDE. (3 units)			✓		
PLS 475A,* Physiology of Plant Production under Controlled Environment – Students will learn the major environmental factors affecting plant growth and development and will understand interactions between plants and their microenvironments, including light penetration and CO2/H2O diffusion. Students will learn energy and mass balance of leaves and canopy and correlate these phenomena with plant productivity and related plant physiological mechanisms. Lectures cover critical controlled environment issues and practices of plant production in greenhouse, plant production factory, tissue culture vessels and post-harvest storage, with an introduction to the current research status in these areas. This course will be offered in spring of even years. May be co-convened with PLS 575A. (3 units)	✓				Introductory plant physiology course
SWES 397A, Teaching Workshop – The practical application of theoretical learning within a group setting and involving an exchange of ideas and practical methods, skills, and principles. (3-4 units)	✓		✓		
WSM 467 Advanced Watershed Hydrology – Advanced topics in watershed hydrology; rainfall-runoff, infiltration, overland	✓				WSM 460

flow routing, sediment modeling, statistical analysis, and research methods in hydrology. (3 units)					