UMSL/Washington University Joint Undergraduate Engineering Program

General Information

The Joint Undergraduate Engineering Program of UMSL and Washington University was approved in 1993 by the University of Missouri and the Coordinating Board for Higher Education. The program is designed to offer course work beyond the pre-engineering courses at UMSL and the area community colleges. Pre-engineering and general education courses are offered at UMSL, and upper-level engineering courses are offered in the late afternoons, evenings and on Saturdays on the Washington University campus: this schedule permits students to co-op during the day at local engineering firms. Students will be admitted to the upper-division program only after they have completed an acceptable pre-engineering program. They can earn a bachelor of science in civil engineering (B.S.C.E.), a bachelor of science in electrical engineering (B.S.E.E.), or a bachelor of science in mechanical engineering (B.S.M.E.).

Mission Statement

The mission of the University of Missouri-St. Louis/Washington University Joint Undergraduate Engineering Program is to provide a high quality engineering education preparing students to meet the evolving expectations of industry. The program strives to excite and nurture the intellectual, technical, professional and personal development of the students through a partnership that provides a mechanism for Washington University to share its campus, resources and personnel with the UMSL students, many of whom are place-bound individuals. The Joint Program educates students from the diverse St. Louis community to elevate their future to enter the engineering profession, thereby elevating the St. Louis region.

Program Educational Objectives

Our program aspires to make positive, substantive and lasting contributions to the lives of our students. The nontraditional and traditional students in the civil, mechanical and electrical engineering programs often have work experience in or related to engineering practice or the military. The program seeks to impart an education that inspires the graduates to constantly share their knowledge with others, to continually improve their knowledge and understanding, and to persistently adapt to change in technology and world needs. Graduates should be able to apply their comprehensive education with the highest ethical standards within the civil, mechanical and electrical engineering profession or a related field. The objectives are to:

- Meet the needs of employers of civil, mechanical, and electrical engineers, with an emphasis on the St. Louis region.
- Meet the expectations of graduate schools that our alumni attend.

Student Outcomes

The student outcomes are the skills and knowledge expected of all students at the time of their graduation. Faculty members will assess these student outcomes in their classes every semester. The student outcomes for the Engineering Program are:

- An ability to apply knowledge of mathematics, science and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- An ability to function on multidisciplinary teams
- An ability to identify, formulate, and solve engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- A recognition of the need for, and an ability to engage in, life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

The B.S.C.E., the B.S.E.E., and the B.S.M.E. are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET), 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700.

Admission

Students are admitted to the upper-division program after they have completed an acceptable pre-engineering program. The pre-engineering program can be taken at University of Missouri-St. Louis or at community colleges in the area. Normally, admission is granted to persons who have completed the pre-engineering program with a minimum grade point average of 2.75 over all their mathematics, chemistry, physics, and introductory (statics and dynamics) engineering courses. Students with less than a 2.75 grade point average, but at least a C, in all their science, engineering and mathematics courses may be admitted on a conditional basis.

For more information, please contact the program advisor at (314) 516-7018.

Fees

Students register on the UMSL campus and pay UMSL fees plus an engineering fee for engineering courses. Limits on enrollments are determined by the availability of resources.

Career Outlook

Engineering is one of the few careers in which the bachelor's degree is a professional degree. Students earning a bachelor of science degree in one of the engineering disciplines are well qualified for entry-level engineering positions in a variety of businesses, industries, consulting firms, and government agencies. As society becomes increasingly dependent on technology, the outlook for all engineering disciplines becomes increasingly bright. Engineering careers typically rank at, or very near, the top of virtually any published rating of promising jobs for the 21st Century. Besides tackling challenging technical problems, roughly two-

thirds of all engineers will have some level of management responsibility within ten years of receiving their bachelor's degrees. Many practicing engineers will eventually continue their education by pursuing graduate degrees on a part-time basis. Typical areas of graduate study include all advanced technical and scientific fields and management.

For Further Information

For information about enrolling in this program, please contact the UMSL/Washington University Joint Undergraduate Engineering Program at 314-516-6800.

Degree Requirements

- Bachelor of Science in Civil Engineering
- Bachelor of Science in Electrical Engineering
- Bachelor of Science in Mechanical Engineering

A program of 132 semester hours is required for the Bachelor of Science in Civil Engineering, a program of 122 semester hours is required for the Bachelor of Science in Electrical Engineering, and a program of 134 semester hours is required for the Bachelor of Science in Mechanical Engineering, as shown below:

- All majors must complete the University General Education requirements (http://bulletin.umsl.edu/generaleducationrequirements), the Pre-Engineering Requirements and the Core Engineering Requirements.
- All students must first complete J E MATH 3170, Engineering Mathematics, with a minimum grade of C-.
- Mechanical and Electrical Engineering majors must also complete J E ENGR 2300, Introduction to Electrical Networks with a minimum grade of C-.
- A minimum grade of C- is necessary to meet the prerequisite requirement for any course.

Pre-Engineering Requirements

Students seeking to major in engineering are first designated as ‘Undeclared with an interest in Engineering majors’ until they have completed Math 1800 Analytical Geometry & Calculus I. Upon successful completion of Math 1800 with a grade of C or better, students will be allowed to declare pre-engineering as their major. Math 1800 must be completed successfully within two attempts.

MATH 1800	Analytic Geometry and Calculus I	5
MATH 1900	Analytic Geometry and Calculus II	5
MATH 2000	Analytic Geometry and Calculus III	5
MATH 2020	Introduction to Differential Equations	3
CHEM 1111	Introductory Chemistry I	5
PHYSICS 2111	Physics: Mechanics and Heat	5
PHYSICS 2112	Physics: Electricity, Magnetism, and Optics	5
ENGR 2310	Statics	3
ENGR 2320	Dynamics	3
ENGL 1100	First-Year Writing	3
Total Hours		42

Civil engineering majors must also complete **GEOL 1001A** , General Geology as part of the pre-engineering requirements (3 Hours).

General Education Requirements

PHIL 2259	Engineering Ethics	3
PHIL 3380	Philosophy of Science	3
HIST 1001	American Civilization to 1865	3
or HIST 1002	American Civilization 1865 to Present	
or HIST 1004	The History Of Women In The United States	
Three additional Social Science courses [1]		9
Total Hours		18

[1] One course must meet the Cultural Diversity requirement, and one course must meet the engineering Valuing Skill requirement. Humanities and social sciences electives must meet both the University of Missouri-St. Louis General Education Requirements and the Humanities and Social Sciences Requirements of the Joint Undergraduate Engineering Program. Check with your advisor for details.

Engineering Core Requirements

CMP SCI 1250	Introduction to Computing	3
J E COMM 2000	Engineering Studio I	1
J E MATH 3170	Engineering Mathematics	4
ENGL 3130	Technical Writing	3
Total Hours		11

Civil Engineering Major Requirements

J C ENGR 2160	Surveying	3
J C ENGR 3410	Structural Analysis	3
J C ENGR 3420	Structural Design	3
J C ENGR 3360	Civil Engineering Materials Lab	1
J C ENGR 3460	Transportation Engineering	3
J C ENGR 3760	Hydraulic Engineering	3
J C ENGR 4190	Soil Mechanics	3
J C ENGR 4200	Soil Exploration And Testing	1
J C ENGR 4600	Highway and Traffic Engineering	3
J C ENGR 4640	Foundation Engineering	3
J C ENGR 4670	Structure Design Projects	3
or J C ENGR 4910	Water Hydrology and Hydraulic Design Project	
J C ENGR 4730	Construction Operations And Management	3
J C ENGR 4740	Economic Decisions In Engineering	3
J C ENGR 4950	Fundamentals Of Engineering Review	1
J C ENGR 4990	Senior Civil Engineering Seminar	1
J M ENGR 1413	Introduction To Engineering Design: CAD	2
J M ENGR 2410	Mechanics Of Deformable Bodies	3
J M ENGR 3360	Material Science For J C ENGR	3
J M ENGR 3700	Fluid Mechanics	3
J M ENGR 3721	Fluid Mechanics Laboratory	1
MATH 1320	Applied Statistics I	3
Civil Engineering Electives		6
Total Hours		58

Electrical Engineering Major Requirements

J CMP SC 1002	Introduction To Computing Tools: Matlab Skills	1
J E ENGR 2320	Introduction To Electronic Circuits	3
J E ENGR 2300	Introduction To Electrical Networks	3
J E ENGR 2330	Electrical And Electronic Circuits Laboratory	3
J E ENGR 2600	Introduction To Digital Logic And Computer Design	3
J E ENGR 3300	Engineering Electro Magnetic Principles	3
J E ENGR 3310	Electronics Laboratory	3
J E ENGR 3320	Power, Energy And Polyphase Circuits	3
J E ENGR 3510	Signals And Systems	3
J E ENGR 4350	Electrical Energy Laboratory	3
J E ENGR 4410/ J M ENGR 4310	Control Systems I	3
J E ENGR 4980	Electrical Engineering Design Projects	3
J E MATH 3260	Probability And Statistics For Engineering	3
J M ENGR 3200	Thermodynamics	3
Electrical Engineering	Electives 3000-4990	12
Total Hours		52

Mechanical Engineering Major Requirements

J C ENGR 4950	Fundamentals Of Engineering Review	1
J CMP SC 1002	Introduction To Computing Tools: Matlab Skills	1
J E ENGR 2300	Introduction To Electrical Networks	3
J E ENGR 2340	Electrical Laboratory for Mechanical Engineers	1
J E MATH 3260	Probability And Statistics For Engineering	3
J M ENGR 1413	Introduction To Engineering Design: CAD	2
J M ENGR 1414	Introduction To Engineering Design: Project	2
J M ENGR 2110	Machine Shop, Fabrication, and Prototyping	
J M ENGR 2410	Mechanics Of Deformable Bodies	3
J M ENGR 3110	Mechanical Design And Machine Elements	3
J M ENGR 3200	Thermodynamics	3
J M ENGR 3250	Material Science For J M ENGR	4
J M ENGR 3700	Fluid Mechanics	3
J M ENGR 3710	Principles Of Heat Transfer	3
J M ENGR 3721	Fluid Mechanics Laboratory	1
J M ENGR 3722	Heat Transfer Laboratory	1
J M ENGR 4041	Current Topics In Engineering Design	1
J M ENGR 4120	Design of Thermal Systems	3
J M ENGR 4170	Dynamic Response Of Physical Systems	2
J M ENGR 4180	Dynamic Response Laboratory	1
J M ENGR 4110	Mechanical Engineering Design Project	3
J M ENGR 4310/ J E ENGR 4410	Control Systems I	3
Mechanical Engineering Electives		12
Total Hours		59

Engineering Design and Engineering Science Requirements

The number of semester hours assigned to each engineering course in the Joint Undergraduate Engineering Program is further divided into hours of engineering design, engineering science, and basic science content. Engineering topics is the sum of engineering science hours and engineering design hours. The following table shows the design hours and engineering science hours for courses in the engineering programs.

Each engineering student must complete a curriculum that contains at least 48 hours of engineering topics semester hours, including all courses: pre-engineering requirements, engineering core requirements, major requirements, and electives. Civil, electrical, and mechanical engineering majors should consult with their advisers to select electives at the 3000 and 4000 level that include sufficient engineering design and engineering science content to produce the required totals. Transfer courses from other institutions do not necessarily have the same engineering science and engineering design content as their equivalents in the UMSL/ Washington University Joint Undergraduate Engineering Program. Students who include transfer courses in their curricula should consult with their advisers to be sure that these requirements are met.

Graduation Requirements

In addition to the requirements of the University of Missouri-St. Louis that apply to all candidates for undergraduate degrees, the student must earn a minimum campus grade point average of 2.0 and a minimum grade point average of 2.0 for all engineering courses attempted at the University of Missouri-St. Louis.

Latin Honors Requirements

In accordance with the University's Latin Honors policy (http://bulletin.umsl.edu/undergraduatestudy/#academicrecognitiontext), candidates graduating from the University of Missouri St. Louis/ Washington University Join Undergraduate Engineering Program in the 2018-2019 Academic Year must meet the following GPA qualifications:

Summa Cum Laude	3.925
Magna Cum Laude	3.791
Cum Laude	3.518

Minor in Electrical Engineering

Admission to the Joint Engineering program is required. A minimum of 18 credit hours in Joint Electrical Engineering courses are required.

Required Courses:		
J E ENGR 2300	Introduction To Electrical Networks	3
J E ENGR 2330	Electrical And Electronic Circuits Laboratory	3
Take three courses from the following list:		9
J E ENGR 2320	Introduction To Electronic Circuits	
J E ENGR 2600	Introduction To Digital Logic And Computer Design	

J E ENGR 3300	Engineering Electro Magnetic Principles	
J E ENGR 3310	Electronics Laboratory	
J E ENGR 3320	Power, Energy And Polyphase Circuits	
J E ENGR 3510	Signals And Systems	
J E ENGR 4350	Electrical Energy Laboratory	
J E ENGR 4410	Control Systems I	
At least one additional J E ENGR Course		3
Total Hours		18

Minor in Mechanical Engineering

Admission to the Joint Engineering program is required. A minimum of 19 credit hours in Joint Mechanical Engineering and Engineering courses are required.

Required Courses		
ENGR 2310	Statics	3
ENGR 2320	Dynamics	3
J M ENGR 2410	Mechanics Of Deformable Bodies	3
Choose at least one laboratory course from the following:		1-4
J M ENGR 3250	Material Science For J M ENGR	
J M ENGR 3721	Fluid Mechanics Laboratory	
J M ENGR 3722	Heat Transfer Laboratory	
J M ENGR 4180	Dynamic Response Laboratory	
Select nine additional credit hours in J M ENGR numbered 3000-4999		9
Total Hours		19-22

Minor in Civil Engineering

Admission to the Joint Engineering program is required. A minimum of 18 credit hours in Joint Civil Engineering courses and Engineering courses are required.

Required Courses		
ENGR 2310	Statics	3
J M ENGR 2410	Mechanics Of Deformable Bodies	3
J M ENGR 3700	Fluid Mechanics	3
Take at least three courses from one of the tracks below:		9
Structures		
J C ENGR 2160	Surveying	
J M ENGR 3360	Material Science For J C ENGR	
J C ENGR 3410	Structural Analysis	
J C ENGR 3420	Structural Design	
J C ENGR 4630	Design Of Steel Structures	
J C ENGR 4660	Advanced Design Of Concrete Structures	
Water Resources/Environmental		
J C ENGR 3520	Water and Wastewater Treatment	
J C ENGR 3760	Hydraulic Engineering	
J C ENGR 4830	Fundamentals of Surface Water Hydrology and Environmental Engineering	
J C ENGR 4740	Economic Decisions In Engineering	
Transportation		
J C ENGR 2160	Surveying	
J C ENGR 3460	Transportation Engineering	
J C ENGR 4600	Highway and Traffic Engineering	
Geotechnical		
GEOL 1001A	General Geology Lecture	
J C ENGR 2160	Surveying	
J M ENGR 3360	Material Science For J C ENGR	
J C ENGR 4190	Soil Mechanics	
J C ENGR 4640	Foundation Engineering	
J C ENGR 4740	Economic Decisions In Engineering	
Construction Management		
J C ENGR 2160	Surveying	
J C ENGR 4720	Legal Aspects Of Construction	
J C ENGR 4730	Construction Operations And Management	
J C ENGR 4740	Economic Decisions In Engineering	
Total Hours		18

Sample Four Year Plans

BS Electrical Engineering (p. 4) BS Civil Engineering (p. 5)
BS Mechanical Engineering (p. 5)

Electrical Engineering

First Year

Fall	Hours	Spring	Hours
MATH 1800	5	HIST 1001 or 1002	3
CHEM 1111	5	MATH 1900	5
ENGL 1100	3	EXPLORE – Humanities & Fine Arts	3
ENGR 1010	1	EXPLORE – Social Sciences	3
	14		14

Second Year

Fall	Hours	Spring	Hours	Summer	Hours
PHIL 2259	3	PHIL 3380	3	ENGR 2320	3
PHYSICS 2111	5	PHYSICS 2112	5		
MATH 2000	5	ENGR 2310	3		
EXPLORE – Social Sciences	3	MATH 2020	3		
	16		14		3

Third Year

Fall	Hours	Spring	Hours	Summer	Hours
J E ENGR 2300	3	J E ENGR 3300	3	J E ENGR 3510	3
J CMP SC 1002	1	J E ENGR 2330	3		
CMP SCI 1250	3	J E ENGR 2320	3		
ENGL 3130	3	J M ENGR 3200	3		
J E MATH 3170	4				
J E COMM 2000	1				
	15		12		3

Fourth Year

Fall	Hours	Spring	Hours
J E ENGR 4410	3	J E ENGR Elective	6
J E ENGR elective	3	J E ENGR 4350	3
J E ENGR 2600	3	J E ENGR 3320	3
J E ENGR 3310	3		
	12		12

Fifth Year

Fall	Hours
J E ENGR Elective	3
MATH 1320	3
J E ENGR 4980	3
	9

Total Hours: 124

PLEASE NOTE: This plan is an example of what a four year plan could look like for a typical student. Placement exam scores in math as well as the completion of coursework may change the plan. It should not be used in the place of regular academic advising appointments. All students are encouraged to meet with their advisor each semester. All requirements are subject to change.

Civil Engineering

First Year

Fall	Hours	Spring	Hours
MATH 1800	5	HIST 1001 or 1002	3
CHEM 1111	5	GEOL 1001A	4
ENGL 1100	3	MATH 1900	5
ENGR 1010	1	EXPLORE – Social Sciences	3
	14		15

Second Year

Fall	Hours	Spring	Hours
MATH 2000	5	ENGR 2310	3
PHYSICS 2111	5	MATH 2020	3
PHIL 2259	3	PHIL 3380	3
EXPLORE – Humanities & Fine Arts	3	PHYSICS 2112	5
		EXPLORE – Social Sciences	3
	16		17

Third Year

Fall	Hours	Spring	Hours	Summer	Hours
J M ENGR 1413	2	J C ENGR 2160	3	J M ENGR 3360	3
J M ENGR 2410	3	J C ENGR 3460	3	J C ENGR 3360	1
J E MATH 3170	4	J M ENGR 3700	3		
ENGR 2320	3	MATH 1320	3		
J E COMM 2000	1				
	13		12		4

Fourth Year

Fall	Hours	Spring	Hours
J C ENGR 3410	3	J C ENGR 3420	3
J C ENGR 4600	3	J C ENGR 4190	3
J C ENGR 4740	3	J C ENGR 4200	1
J M ENGR 3721	1	CMP SCI 1250	3
ENGL 3130	3		
	13		10

Fifth Year

Fall	Hours	Spring	Hours
J C ENGR 4630	3	J C ENGR 3760	3
J C ENGR 4640	3	J C ENGR 4660	3
J C ENGR 4730	3	J C ENGR 4670	3
J C ENGR 4990	1	J C ENGR 4950	1
	10		10

Total Hours: 134

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Mechanical Engineering

First Year

Fall	Hours	Spring	Hours
MATH 1800	5	HIST 1001 or 1002	3
CHEM 1111	5	MATH 1900	5
ENGL 1100	3	EXPLORE – Humanities & Fine Arts	3
ENGR 1010	1	EXPLORE – Social Sciences	3
	14		14

Second Year

Fall	Hours	Spring	Hours	Summer	Hours
PHIL 2259	3	MATH 2020	3	ENGR 2320	3
MATH 2000	5	PHIL 3380	3		
PHYSICS 2111	5	ENGR 2310	3		
EXPLORE – Social Sciences	3	PHYSICS 2112	5		
	16		14		3

Third Year

Fall	Hours	Spring	Hours	Summer	Hours
J CMP SC 1002	1	J M ENGR 1414	2	J M ENGR 3250	4
J E MATH 3170	4	J M ENGR 2110	2		
J E ENGR 2300	3	J M ENGR 2410	3		
J E COMM 2000	1	ENGL 3130	3		
CMP SCI 1250	3				
	12		10		4

Fourth Year

Fall	Hours	Spring	Hours	Summer	Hours
J M ENGR 1413	2	J M ENGR 3200	3	J M ENGR 4170	2
MATH 1320	3	J M ENGR 4900	3	J M ENGR 4180	1
J E ENGR 2340	1	J M ENGR 3700	3		
J M ENGR Elective	3	J M ENGR 3010	3		
	9		12		3

Fifth Year

Fall	Hours	Spring	Hours	Summer	Hours
J M ENGR 3710	3	J M ENGR 3722	1	J M ENGR 4110	3
J M ENGR 3110	3	J M ENGR 3750	3		
J M ENGR 3721	1	J M ENGR 4120	3		
J M ENGR 4041	1	J C ENGR 4950	1		
J M ENGR 4310	3				
	11		8		3

Total Hours: 133

PLEASE NOTE: This plan is an example of what a four year plan could look like for a typical student. Placement exam scores in math as well as the completion of coursework may change the plan. It should not be used in the place of regular academic advising appointments. All students are encouraged to meet with their advisor each semester. All requirements are subject to change.

Engineering Courses

ENGR 1010 Introduction to Engineering: 1 semester hour
This course, required of all new Freshman with an Interest in Engineering, is designed to assist students in their transition to the university experience and to UMSL by giving students the knowledge and tools needed to succeed as scholars. Students will learn about faculty expectations, support services, and student life, as well as engineering.

ENGR 2310 Statics: 3 semester hours
Prerequisites: MATH 1900 and PHYSICS 2111. Statics of particles and rigid bodies. Equivalent systems of forces. Distributed forces; centroids. Applications to trusses, frames, machines, beams, and cables. Friction. Moments of inertia. Principle of virtual work and applications.

ENGR 2320 Dynamics: 3 semester hours
Prerequisite: ENGR 2310. Review of vector algebra and calculus. Kinematics of a particle. Newton's laws and the kinetics of a particle. Work and energy. Impluse and momentum. Kinematics of rigid bodies. General theorems for systems of particles. Kinetics of rigid bodies. The inertia tensor.

Joint Civil Engineering Courses

J C ENGR 2160 Surveying: 3 semester hours
Horizontal and vertical control surveys, including traverses, triangulation, trilateration, and leveling; basic adjustments of observations; geologic data; coordinate systems. Basic route surveying, including horizontal and vertical curves.

J C ENGR 3360 Civil Engineering Materials Lab: 1 semester hour
Testing procedures, testing machines, use of laboratory equipment, analysis of data, and presentation of results. Laboratory tests on static tension, compression, bending, and torsion of metal specimens. Tests on wood. Determination of compressive and tensile strengths of concrete. Design of concrete mixes and verification of strength. Experiments in advanced topics in mechanics of materials.

J C ENGR 3410 Structural Analysis: 3 semester hours
Prerequisite: J M ENGR 2410. A review of the calculation of reactions, shear, and bending moment. Definition, construction and use of influence lines. Deflections for statically determinate structures using the work method. Analysis of statically indeterminate trusses using the method of consistent deformations. Analysis of continuous beams and planar frames using the consistent deformation, slope-deflection and moment distribution methods. The influence of span on strength, stability, and economy of structures. An introduction to structural analysis software.

J C ENGR 3420 Structural Design: 3 semester hours
Prerequisites: J M ENGR 3250, J C ENGR 3410. Fundamentals of structural design in steel, reinforced concrete, and timber. Familiarization with the sources of various design codes and practice in interpreting them. Computer graphics applications.

J C ENGR 3460 Transportation Engineering: 3 semester hours
Fundamental treatment of the planning, engineering, design, and procedural aspects of multimodal transportation are covered. Intermodal freight and urban transportation planning processes and overview of environmental, energy, and economic issues are discussed.

J C ENGR 3520 Water and Wastewater Treatment: 3 semester hours
Prerequisites: J M ENGR 3700 (may be taken concurrently) or permission of instructor. Application of the basic principles of chemistry, microbiology, and fluid mechanics to the analysis of environmental problems, especially those involving control of water and land contamination. Properties of municipal and industrial wastewater, solid waste, and hazardous waste. Estimation of assimilative capacity and other characteristics of receiving waters. Introduction to unit processes and unit operations used in the treatment of municipal and industrial wastewater. Design of processes and facilities used for treating drinking water, wastewater, and sludge disposal. Waste minimization and recycling in both industrial and municipal settings.

J C ENGR 3760 Hydraulic Engineering: 3 semester hours
Prerequisites: J M ENGR 3700. The principles of open channel flow will be discussed and illustrated with practical examples. Methods for channel design, storm sewer, culvert and brige analysis will be presented using the concepts of gradually-varied, steady flow. A design project using computerized analysis and design is used to implement concepts in a large practical application.

J C ENGR 4000 Independent Study: 1-6 semester hours
Prerequisites: Junior standing and consent of faculty advisor. Independent investigation of a civil engineering topic of special interest to a student performed under the direction of a faculty member.

J C ENGR 4190 Soil Mechanics: 3 semester hours
Prerequisite: J M ENGR 2410, J M ENGR 3700. Basic geology as it relates to index and classification properties of soil. Exploration, sampling, and testing techniques. Soil classification systems. clay minerals and soil structures. Compaction and stabilization. Capillary, shrinkage, swelling, and frost action in soils. Effective stress, permeability, seepage,and flow nets. Consolidation and consolidation settlements. stresses in soil. Time rate of consolidation. Mohr's circle, stress path, and failure theories. Shearing strength of sand and clays.

J C ENGR 4200 Soil Exploration and Testing: 1 semester hour
Prerequisite: J C ENGR 4190 (may be taken concurrently). Soil exploration; in-situ soil testing, laboratory testing of soil; processing of test data using a microcomputer; statistical analysis of test data; use of test results in the decision-making process.

J C ENGR 4600 Highway and Traffic Engineering: 3 semester hours
Prerequisites: J C ENGR 2160 and Senior Standing. Study of basic highway design and traffic circulation principles. Study of design elements of alignment, profile, crosssection, intersection types, interchange types, and controlledaccess highways. Investigation of functional highway classification. Traffic volume, delay and accident studies. Analysis of highway capacity of uninterrupted flow, interrupted flow. Freeway, ramp and weaving sections.

J C ENGR 4630 Design of Steel Structures: 3 semester hours
Prerequisites: J C ENGR 3410, J C ENGR 3420. Behavior and design of steel frames by "allowable stress" and "maximum strength" based on deterministic and LRFD (Load-resistance factor design) methods. Design of beams, columns, beamcolumns, plate girders, connections, multistory frames, and bridge girders, Torsional design of steel structures. Plastic analysis and design of steel structures. Miscellaneous topics in structural steel construction and design.

J C ENGR 4640 Foundation Engineering: 3 semester hours
Prerequisites: J C ENGR 3420, J C ENGR 4190, J C ENGR 4200. Principal problems in design and construction of foundations for bridges and buildings. Bearing capacity of deep and shallow foundations; pressure on retaining walls and shallow foundations; pressure on retaining walls and slope stability; modern developments in piling, cofferdams, open caissons, pneumatic caissons.

J C ENGR 4660 Advanced Design of Concrete Structures: 3 semester hours
Prerequisites: J M ENGR 3250, J C ENGR 3410, J C ENGR 3420. Flexural behavior and design, strength and deformation of rectangular and nonrectangular sections, shear strength, beamcolumns, long columns, slab systems, design of frames, and footings will be covered.

J C ENGR 4670 Structure Design Projects: 3 semester hours
Prerequisite: Permission of instructor. Students carry out the complete design of typical and unusual building and bridge structures. Use of the computer as a design tool is emphasized. Projects are conducted in cooperation with production engineers.

J C ENGR 4720 Legal Aspects of Construction: 3 semester hours
Prerequisite: Junior standing or permission of instructor. A survey of the legal problems of the construction manager. Including but limited to, liability in the areas of contracts, agency, torts, insurance, bad judgement and oversight.

J C ENGR 4730 Construction Operations and Management: 3 semester hours
Prerequisite: Junior standing. The construction industry, its development, components, and organization. Contracting methods. Applications and limitions. Selection of equipment using production analysis and economics. Field engineering, including form design, shoring, embankment design. Purchasing and change orders. Safety and claims.

J C ENGR 4740 Economic Decisions in Engineering: 3 semester hours
Prerequisite: Junior standing. Principles of economics involved in engineering decisions. Decisions between alternatives based on the efficient allocation of resources. Topics include the time element in economics, analytical techniques for economy studies, and taxes.

J C ENGR 4830 Fundamentals of Surface Water Hydrology and Environmental Engineering: 3 semester hours
Prerequisites: Fluid Mechanics and senior status. The principles of the hydrologic cycle including precipitation, evaporation, transpiration, infiltration, runoff, streamflow, and groundwater will be discussed and illustrated. In addition, computational fundamentals of hydrologic analysis will be presented such as unit hydrographs, routing, data analysis, and flood frequency. Elements of quantitative problems in urban stormwater systems and management, water quality and urbanization. Concepts of sustainability and green engineering such as low impact development and other best management practices will be presented. Computer software will be utilized.

J C ENGR 4910 Water Hydrology and Hydraulic Design Project: 3 semester hours
Prerequisites: J M ENGR 3700, J C ENGR 3760, and J C ENGR 4830. This course is designed to provide seniors in Hydrology and Hydraulics with a major design/facility plan project. The principals of hydrologic and hydraulic design will be utilized in developing the hydrology, hydraulics and floodplain analysis for a local watershed or land area. Hydrologic analysis is performed to size hydraulic systems and evaluate watershed and floodplain performance. The course is structured to apply hydrologic theory and modeling techniques to engineering hydrology and hydraulics for watershed analysis, floodplain delineation, and urban stormwater. The student will also consider the next generation of hydrologic computation, watershed evaluation and the importance of severe storm impacts and flood management. Consideration of sustainability and green infrastructure practices will also be included. A final written report and class presentation of the design project is included.

J C ENGR 4950 Fundamentals of Civil Engineering Review: 1 semester hour
Prerequisite: Senior standing. A review and preparation of the most recent NCEES Fundamentals of Engineering (FE) Exam specifications for Civil Engineering students is offered in a classroom setting. Exam strategies will be illustrated using examples.

J C ENGR 4990 Senior Civil Engineering Seminar: 1 semester hour
Prerequisite: Senior standing. Students will research assigned topics of importance to graduates entering the Civil Engineering profession and prepare oral presentations and a written report. Student presentations will be augmented by lectures from practicing professionals. Topics include professional registration, early career development, graduate study, effective presentations, construction quality, and case histories of civil engineering projects.

Joint Computer Science Courses

J CMP SC 1002 Introduction To Computing Tools: Matlab Skills: 1 semester hour
This course is aimed at the acquisition of MATLAB skills through hands-on familiarization and practice. Students practice the array, vector, and meshgrid representations, programming and plotting, and apply these skills to solve numerical problems and generate reports. (J CMP SC 1002 and CMP SCI 1250 can substitute for J CMP SC 1360).

Joint Electrical Engineering Courses

J E ENGR 2300 Introduction to Electrical Networks: 3 semester hours
Elements, sources, and interconnects. Ohm's and Kirchoff's laws, superposition and Thevenin's theorem; the resistive circuit, transient analysis, sinusoidal analysis, and frequency response.

J E ENGR 2320 Introduction to Electronic Circuits: 3 semester hours
Prerequisites: J E ENGR 2300. Introduction to contemporary electronic devices and their circuit applications. Terminal characteristics of active semiconductor devices. Incremental and D-C models of junction diodes, bipolar transistor (BJTs), and metal-oxide semiconductor field effect transistors (MOSFETs) are developed and used to design single-and multi-stage amplifiers, Models of the BJT and MOSFET in cutoff and saturation regions are used to design digital circuits.

J E ENGR 2330 Electrical and Electronic Circuits Laboratory: 3 semester hours
Prerequisites: J E ENGR 2300. Lectures and laboratory exercises related to sophomore topics in introductory networks and basic electronics.

J E ENGR 2340 Electrical Laboratory for Mechanical Engineers: 1 semester hour
Prerequisites: J E ENGR 2300. Laboratory in introductory electrical circuits and devices of relevance to mechanical engineers.

J E ENGR 2600 Introduction to Digital Logic and Computer Design: 3 semester hours
Prerequisite: J CMP SC 1260. Digital computers and digital information-processing system; Boolean algebra, principles and methodology of logical design; machine language programming; register transfer logic; microprocessor hardware, software, and interfacing; fundamental of digital circuits and systems; computer organization and control; memory systems; arithmetic unit design. Occasional laboratory exercises.

J E ENGR 3300 Engineering Electro Magnetic Principles: 3 semester hours
Electromagnetic theory as applied to electrical engineering; vector calculus; electrostatics and magnetostatics; Maxwell's e quations, including Poynting's theorem and boundry conditions; uniform plane-wave propagation; transmission lines-TEM modes, including treatment of general, lossless line, and pulse propagation; introduction to guided waves; introduction to radiation and scattering concepts.

J E ENGR 3310 Electronics Laboratory: 3 semester hours
Prerequisites: J E ENGR 2300, J E ENGR 2330. Laboratory exercises for juniors covering topics in computeraided measurements, computer simulation, and electronic circuits.

J E ENGR 3320 Power, Energy and Polyphase Circuits: 3 semester hours
Prerequisite: J E ENGR 2300. Fundamental concepts of power and energy; electrical measurements; physical and electrical arrangement of electricl power systems; polyphase circuit theory and calculations; principle elements of electrical systems such as transformers, rotating machines, control, and protective devices, their description and characteristics; elements of industrial power system design.

J E ENGR 3360 Principles of Electronic Devices: 3 semester hours
Introduction to the solid-state physics of electronic materials and devices, including semiconductors, metals, insulators, diodes and transistors, Crystals growth technology and fundamental properties of crystals. Electronic properties and band structure of electronic materials, and electron transport in semiconductor materials. Fabrication of pn junction diodes, metal-semiconductor junctions, and trnasistors and integratedcircuit chips. Fundamental electrical properties of rectifying diodes and light-emitting diodes, bipolar transistors and field effect transistors. Device physics of diodes and transistors, large-signal electrical behavior and high-frequency properties.

J E ENGR 3370 Electronic Devices and Circuits: 3 semester hours
Prerequisites: J E ENGR 2320. Introduction to semiconductor electronic devices: transistors and diodes. Device electrical DC and high-frequency characteristics. Bipolar transistors, field-effect transistors for analog electronics applications. Transistors fabrication as discrete devices and as integrated-circuit chips. Large-signal analysis of transistor amplifiers: voltage gain, distortion, input resistance and output resistance. Analysis of multitransistor amplifiers: Darlington, Cascode, and coupled-pair configurations. Half-circuit concepts, differential-mode gain, common-mode gain, and differential-to-single-ended conversion. Transistor current sources, active loads, and power-amplifier stages. Applications to operational amplifiers and feedback circuits.

J E ENGR 3510 Signals and Systems: 3 semester hours
Prerequisites: J E ENGR 2300 and J E MATH 3170. Elementary concepts of continuous-time and discrete-time signals and systems. Linear time-invariant (LTI) systems, impulse response, convolution, Fourier series, Fourier transforms, and frequency-domain analysis of LTI systems. Laplace transforms, Z-transforms, and rational function descriptions of LTI systems. Principles of sampling and modulation. Students participate weekly in recitation sections to develop oral communications skills using class materials.

J E ENGR 3620 Computer Architecture: 3 semester hours
Prerequisite: J E ENGR 2600. Study of interaction and design philosophy of hardware and software for digital computer systems: Machine organization, data structures, I/O considerations. Comparison of minicomputer architectures.

J E ENGR 4000 Independent Study: 1-3 semester hours
Prerequisites: Senior in Good Standing. Opportunities to acquire experience outside the classroom setting and to work closely with individual members of the faculty. A final report must be submitted to the department. Open as a senior elective only. Hours and credit to be arranged. Credit variable, maximum credit per semester 3 hours. Maximum program total credit 3 hours.

J E ENGR 4050 Reliability and Quality Control: 3 semester hours
Prerequisites: J E MATH 3260 or MATH 1320. An integrated analysis of reliability and quality control function in manufacturing. Statistical process control, analysis, reliability prediction, design, testing, failure analysis and prevention, maintainability, availability, and safety are discussed and related. Qualitative and quantitative aspects of statistical quality control and reliability are introduced in the context of manufacturing.

J E ENGR 4340 Solid State Power Circuits and Applications: 3 semester hours
Prerequisite: J E ENGR 2320, J E ENGR 3510. Study of the strategies and applications of power control using solid-state semiconductor devices. Survey of generic power electronic converters. Applications to power supplies, motor drives, and consumer electronics. Introduction to power diodes, thyristors, and MOSEFETs.

J E ENGR 4350 Electrical Energy Laboratory: 3 semester hours
Prerequisites: J E ENGR 2330. Experimental studies of principles important in modern electrical energy systems. Topics: power measurement, transformers, batteries, static frequency converters, thermoelectric cooling, solar cells, electrical lighting, induction, commutator, and brushless motors, synchronous machines.

J E ENGR 4360 Energy Alternatives: 3 semester hours
Prerequisites: J E ENGR 2300, or J M ENGR 3200. This course introduces engineering analyses of the human uses of energy. Both non-renewable (e.g., oil, natural gas, coal, nuclear) and sustainable (e.g., hydropower, solar, wind, biomass) resources are covered. Topics include the engineer's role in harvesting, production, storage, conversion, delivery, and uses of energy. Students will learn system analysis, design, integration, optimization, and operational aspects of selected resources delivery systems, and end uses. Technical content will include site selection, conversion and delivery efficiency calculations, engineering economic analyses, control systems, and energy resource systematic classification. Measure will consist of a mix of homework, quizzes, tests, class participation, and projects.

J E ENGR 4410 Control Systems I: 3 semester hours
Same as J M ENGR 4310. Prerequisites: J E MATH 3170, J E ENGR 2300. Introduction to automatic control concepts. Block diagram representation of single and multiloop systems. Multi-input and multi-output systems. Control system components. Transient and steady-state performance; stability analysis; Routh, Nyquist, Bode, and root locus diagrams. Compensation using lead, lag and lead-lag networks. Synthesis by Bode plots and root-locus diagrams. Introduction to state-variable techniques, state-transition matrix, state-variable feedback.

J E ENGR 4440 Sensors and Actuators: 3 semester hours
Prerequisites: Senior standing. The course provides engineering students with basic understanding of two of the main components of any modern electrical or electromechanical system; sensors as inputs and actuators as outputs. This course is useful for those students interested in control engineering, robotics and systems engineering.

J E ENGR 4520 Power Systems Analysis: 3 semester hours
Prerequisite: J E ENGR 3320. Introduction to the modeling and elements of power systems; machines, lines, and loads; load flow methods and applications; short circuit analysis using symmetrical components on symmetrical and unsymmetrical faults; methods of economic operation of power systems and contingency; state estimators, stability, and introduction of the independent system operator.

J E ENGR 4710 Communications Theory and Systems: 3 semester hours
Prerequisites: J E ENGR 3510 and J E MATH 3260. Introduction to the concepts of transmission of information via communication channels. Amplitude and angle modulation for the transmission of continuous-time signals. Analog-to-digital conversion and pulse code modulation. Transmission of digital data. Introduction to random signals and noise and their effects on communication. Optimum detection systems in the presence of noise. Elementary information theory. Overview of various communication technologies such as radio, television, telephone networks, data communication, satellites, optical fiber, and cellular radio.

J E ENGR 4720 Internet Communications: 3 semester hours
This course will introduce and cover the architecture, protocols, security, and quality of service (QoS) of Internet Communications. Starting with the design principles and architecture of the Internet, communication applications such as Voice over IP (VoIP), video conferencing, and presence and instant messaging will be covered. Protocols developed by the Internet Engineering Task Force (IETF) including IP, TCP, UDP, DNS, SIP, XMPP, and ENUM will be studied. Latest areas of research including the Service Oriented Architecture (SOA) and peer-to-peer (P2P) architectures for Internet Communications will be covered.

J E ENGR 4820 Digital Signal Processing: 3 semester hours
Prerequisite: J E ENGR 3510. Introduction to alalysis and synthesis of discrete-time linear time-invariant (LTI) systems. Discretetime convolution, discrete-time Fourier transform, Z-transform, rational function discriptions of discrete-time LTI systems. Sampling, analog-to-digital conversion and digital processing of analog signals. Techniques for the design of finite impulse response (FIR) and infinite impulse response (IIR) digital filters. Hardward implementation of digital filters and finiteregister effects. The discrete Fourier transform and the fast Fourier transform (FFT) algorithm.

J E ENGR 4950 Fundamentals of Electrical Engineering Review: 1 semester hour
Prerequisites: Senior standing. A review and preparation of the most recent NCEES Fundamentals of Engineering (FE) Exam specifications for Electrical Engineering students is offered in a classroom setting. Exam strategies will be illustrated using examples.

J E ENGR 4980 Electrical Engineering Design Projects: 3 semester hours
Prerequisites: Senior standing. Working in teams, students address design tasks assigned by faculty. Each student participates in one or more design projects in a semester. Projects are chosen to emphasize the design process, with the designer choosing one of several paths to a possible result. Collaboration with industry and all divisions of the univesity is encouraged.

Joint Engineering Mathematics Courses

J E MATH 3170 Engineering Mathematics: 4 semester hours
Prerequisite: MATH 2020 or equivalent. The Laplace transform and applications; series solutions of differential equations, Bessel's equation, Legendre's equation, special functions; matrices, eigenvalues, and eigenfunctions; Vector analysis and applications; boundary value problems and spectral representation; Fourier series and Fourier integrals; solution of partial differential equations of mathematical physics.

J E MATH 3260 Probability and Statistics for Engineering: 3 semester hours
Prerequisites: MATH 2000. Study of probability and statistics together with engineering applications. Probability and statistics: random variables, distribution functions, density functions, expectations, means, variances, combinatorial probability, geometric probability, normal random variables, joint distribution, independence, correlation, conditional probability, Bayes theorem, the law of large numbers, the central limit theorem. Applications: reliability, quality control, acceptance sampling, linear regression, design and analysis of experiments, estimation, hypothesis testing. Examples are taken from engineering applications. This course is required for electrical and mechanical engineering majors.

Joint Mechanical Engineering Courses

J M ENGR 1413 Introduction to Engineering Design: CAD: 2 semester hours
An introduction to engineering design in the context of mechanical engineering. Students learn the fundamentals of spacial reasoning and graphical representation. Freehand sketching, including pictorial and orthographic views, are applied to the design process. Computer modeling techniques provide accuracy, analysis, and visualization tools necessary for the design of devices and machines. Topics in detailing design for production, including fasteners, dimensioning, tolerancing, and creation of part and assembly drawings are also included.

J M ENGR 1414 Introduction to Engineering Design: Project: 2 semester hours
An introduction to engineering design in the context of mechanical engineering. Students first complete a series of experiments that introduce physical pheonomena related to mechanical engineering. Understanding is achieved by designing and building simple devices and machines. The course proceeds toa design contest in which the students design and build from a kit of parts a more significant machine that competes in a contest held at the end of the course. The course is open to all and is appropriate for anyone interested in mechanical devices, design, and the design process.

J M ENGR 2110 Machine Shop, Fabrication, and Prototyping: 2 semester hours
Basic machine shop and mechanical fabrication skills are taught in the context of case studies from prototype design and build projects. After considering possible redesigns, students build the hardware considered in the case study. Through these "build" assignments students learn basic machine shop skills including precision measurement, workholding, sawing, drilling, turning, milling, and grinding. The assignments also provide the opportunity to learn general purpose mechanical fabrication activities including glueing, basic woodwork, welding, and basic electronic control. Completion of the course provides certification to use the Washington University engineering machine shop.

J M ENGR 2410 Mechanics of Deformable Bodies: 3 semester hours
Prerequisites: MATH 1900 and ENGR 2310. Normal and shear stresses and strains. Stress-strain diagrams. Hooke's law and elastic energy. Thermal stresses. Stresses in beams, columns, torsional members, and pressure vessels. Elastic deflection of beams and shafts. Statically indeterminate structures. Mohr's circle of stress. Stability concepts.

J M ENGR 3010 Computer Aided Design: 3 semester hours
Prerequisite; J M ENGR 1413. Computer aided design, analysis and optimization of parts and assemblies; solid modeling of complex surfaces, creation of detail drawings, dimensioning and tolerancing; assembly modeling, assembly constraints, interference checking; motion constraints, force and acceleration analysis, thermal analysis; part optimization for weight, strength and thermal characteristics using Unigraphics software.

J M ENGR 3110 Mechanical Design and Machine Elements: 3 semester hours
Prerequisite: J M ENGR 2410. Provides a thorough overview of the steps in the engineering design process and introduces analytical/ quantitative techniques applicable to each step. Topics include recognition of need, specification formulation, concept generation, concept selection, embodiment, and detail design. Includes an introduction to several classes of machine elements such as shafts, bearings, gears, brakes, and threaded fasteners. Underlying analytical models of the machine elements are presented along with guidelines about designing and choosing such elements for practical applications. Students complete a case study project to conclude the course.

J M ENGR 3200 Thermodynamics: 3 semester hours
Prerequisites: MATH 1900, CHEM 1111 and PHYSICS 2111. Classical thermodynamics; thermodynamic properties; work and heat; first and second laws. Entropy, irreversibility, availability. Application to engineering systems.

J M ENGR 3250 Material Science for J M ENGR: 4 semester hours
Prerequisites: CHEM 1111. Introduces the chemistry and physics of engineering materials. Emphasis on atomic and molecular interpretation of physical and chemical properties, the relationships between physical and chemical properties, and performance of an engineering material.

J M ENGR 3360 Material Science For J C ENGR: 3 semester hours
Same as J M ENGR 3250, but without the lab. Prerequisite: CHEM 1111. Introduces the chemistry and physics of engineering materials Emphasis on atomic and molecular interpretation of physical a chemical properties, the relationships between physical and chemical properties, and performance of an engineering material.

J M ENGR 3700 Fluid Mechanics: 3 semester hours
Prerequisites: J E MATH 3170 and ENGR 2320. Fundamental concepts of fluids as continua. Viscosity. Flow field: velocity, vorticity, streamlines. Fluid statics: hydrostatic forces manometers. Conservation of mass and momentum. Incompressible inviscid flow. Dimensional analysis and similitude. Flow in pipes and ducts. Flow measurement. Boundary-layer concepts. Flow in open channels.

J M ENGR 3710 Principles of Heat Transfer: 3 semester hours
Prerequisites: J M ENGR 3200, J M ENGR 3700 and J E MATH 3170. Introductory treatment of the principles of heat transfer by conduction, convection, or radiation. Mathematical analysis of steady and unsteady conduction along with numerical methods. Analytical and semiempirical methods of forced and natural convection systems. Heat exchangers: LMTD and e-NTU analysis. Boiling and condensation heat transfer. Radiation between blackbody and real surfaces. Radiation network analysis.

J M ENGR 3721 Fluid Mechanics Laboratory: 1 semester hour
Prerequisites: J M ENGR 3700. Physical laboratory exercises focusing on fluid properties and flow phenomena covered in J M ENGR 3700. Calibration and use of a variety of equipment; acquisition, processing, and analysis of data by manual as well as automated methods.

J M ENGR 3722 Heat Transfer Laboratory: 1 semester hour
Prerequisites: J M ENGR 3721 and J M ENGR 3710. Physical laboratory exercises, including some numerical simulations and computational exercises, focusing on heat-transfer phenomena covered in J M ENGR 3710. Calibration and use of variety of laboratory instrumentation; acquisition, processing, and analysis of data by manual as well as automated methods; training in formal report writing.

J M ENGR 3750 Fluid Control and Power Systems Theory and Practice: 3 semester hours
Prerequisite: J M ENGR 3700. Topics to be covered include: design of hydraulic and pneumatic control and power systems using advanced concepts and analytical tools; analysis of fluid flow through small orifices and between parallel and inclined planes; theory of spool and flapper valves; physical configuration of practical components: pumps, motors, fluid lines and valves, accumulators and storage devices; integration of components into practical systems, development of realistic performance diagrams using MATLAB Symulink; application of performanc diagrams in design and analysis of fluid power systems.

J M ENGR 4000 Independent Study: 1-3 semester hours
Prerequisites: Junior standing and consent of faculty advisor. Independent investigation of a mechanical engineering topic of special interest to a student performed under the direction of a faculty member.

J M ENGR 4041 Current Topics in Engineering Design: 1 semester hour
Case studies of engineering failures, class discussion & short written papers are used to illustrate and stress the importance of engineering teamwork, ethics, and professional standards within the mechanical engineering discipline. Working in teams students develop and present a case study on a topic of their choice. Guest lecturers introduce contemporary topics such as product liability, environmental regulations, green design, appropriate technologies, and concurrent engineering.

J M ENGR 4110 Mechanical Engineering Design Project: 3 semester hours
Prerequisites: J M ENGR 3110. Small student teams complete design projects subject to various constraints (e.g. economic, safety, legal, environmental, ethical), and appropriate codes and standards. Teams first perform a background information study, which is followed by a specification and conceptual design study. Embodiment and fabrication plans are produced for the chosen concept. The results of an engineering analysis study influence the final design of a working prototype, which is built and demonstrated. This is "documented" in an appropriate manner (e.g. a CAD model) that allows others to reproduce a version, and it is "published" so that other interested parties learn of its existence.

J M ENGR 4120 Design of Thermal Systems: 3 semester hours
Prerequisites: Senior Standing. Analysis and design of advanced thermo-fluid systems. Student teams participate in the design process which could involve research, design formulation, codes, standards, engineering economics, a design project report, and formal presentations. Topics include: thermal-fluid systems and components, such as power, heating, and refrigeration systems, pumps, fans, compressors, combustors, turbines, nozzles, coils, heat exchangers and piping.

J M ENGR 4170 Dynamic Response of Physical Systems: 2 semester hours
Prerequisites: ENGR 2320 and J E MATH 3170, J M ENGR 4170 and J M ENGR 4180 must be taken in the same semester. Free and forced vibration of mechanical systems with lumped inertia, springs, and dampers. Methods of Laplace transform, complex harmonic balance, and Fourier series. Electrical analogs. Introduction to Lagrange's equations of motion and matrix formulations. Transient response of continuous systems by partial differential equations, by rayleigh methods, and by lumped parameters.

J M ENGR 4180 Dynamic Response Laboratory: 1 semester hour
Prerequisites: J M ENGR 4170 and J M ENGR 4180 must be taken during the same semester. Laboratory problems focusing on materials covered in J M ENGR 4170.

J M ENGR 4250 Material Selection in Engineering Design: 3 semester hours
Prerequisites: Senior standing. Analysis of the scientific bases of material behavior in the light of research contributions of the last 20 years. Development of a rational approach to the selection of materials to meet a wide range of design requirements for conventional and advanced applications. Although emphasis will be placed on mechanical properties, other properties of interest in design will be discussed, e.g., acoustical, optical and thermal.

J M ENGR 4310 Control Systems I: 3 semester hours
Same as J E ENGR 4410. Prerequisites: J E MATH 3170, J E ENGR 2300. Introduction to automatic control concepts. Block diagram representation of single and multi-loop systems. Multi-input and multi-output systems. Control system components. Transient and steady-state performance; stability analysis; Routh, Nyquist, Bode, and root locus diagrams. Compensation using lead, lag, and lead-lag networks. Synthesis by Bode plot plots and root-locus diagrams. Introduction to state-variable techniques, state transition matrix, state-variable feedback.

J M ENGR 4630 Nanotechnology: Concepts and Applications: 3 semester hours
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J M ENGR 4700 Sustainable Environmental Building Systems: 3 semester hours
Sustainable design of building lighting and HVAC systems considering performance, life-cycle cost and downstream environmental impact. Criteria, codes and standards for comfort, air quality, noise/vibration and illumination. Life cycle and other investment methods to integrate energy consumption/conservation, utility rates, initial cost, system/component longevity, maintenance cost and building productivity. Direct and secondary contributions to acid rain, global warming and ozone depletion.

J M ENGR 4706 Aircraft Performance: 3 semester hours
Prerequisites: Senior Standing. This course introduces the principles and applications of aerodynamics to determine the performance of typical jet engine and propeller airplanes. The performance calculations include flight conditions of takeoff, climb, level flight, and landing. The topics covered also include range and endurance computation, turning flight, flight envelope, constraint analysis and design process. The knowledge and skill gained in this course can be readily applied in the preliminary design of an airplane.

J M ENGR 4810 HVAC Analysis and Design I: 3 semester hours
Prerequisites: Senior standing. Moist air properties and the psychrometric chart. Classic moist air processes and design procedures for heating and cooling systems. Design of heating, ventilating, and air conditioning systems for indoor environmental comfort and health. Basics of heat transfer in building structures. Solar radiation effects on building heat transfer. Calculation procedures for the analysis of heating and cooling loads in buildings.

J M ENGR 4820 HVAC Analysis and Design II: 3 semester hours
Prerequisites: Senior standing. Energy calculations to estimate the quantity of energy needed to heat and cool building structures. Fundamentals of incompressible flow, basics of centrifugal pump performance, and design procedures for water piping systems. Space air diffuser design to assure that temperatures, humidities, and air velocities within occupied spaces are acceptable. Air duct design and fan analysis for optimally distributing air through building air duct systems. Performance analysis of refrigeration systems, including the effects of pressure losses and heat transfer. Direct contact heat and mass transfer.

J M ENGR 4900 Engineering Project Management: 3 semester hours
Basic fundamentals and advanced concepts of engineering project management applicable to projects and programs, both large and small. Project management skills, techniques, systems, software and application of management science principles will be covered and related to research, engineering, architectural, and construction projects from initial evaluations through approval, design, procurement, construction and startup.

J M ENGR 4950 Fundamentals of Mechanical Engineering Review: 1 semester hour
Prerequisites: Senior standing. A review and preparation of the most recent NCEES Fundamentals of Engineering (FE) Exam specifications for Mechanical Engineering students is offered in a classroom setting. Exam strategies will be illustrated using examples.