APPENDIX 1-F

Proposal for a B.S. Degree in

K-12 Engineering and Technology Teacher Education

For California State University Los Angeles

NCETE Core 4

(ETE 7040 - Engineering Design in STEM Education, Utah State University)

Spring 2009

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APPENDIX 1-F-1

Proposal for a B.S. Degree in K-12 Engineering and Technology Teacher Education (194 - 197 units)

FOR CALIFORNIA STATE UNIVERSITY, LOS ANGELES

(Note: Bolded course names indicate that the courses are newly proposed. The curriculum structure of the B.S. in Mechanical Engineering is used in the design of this proposed program)

Lower Division General Education Requirements (32 units) → 14 Courses
Note: These are similar requirements as in the Mechanical Engineering B.S. program.

ENGL 101	Composition I: Reflective and Expository Writing (4)
COMM 150	Oral Communication (4)
HIST 202A *or* 202B	United States Civilization (4)
POLS 150	Government and American Society (4)
BLOCK C − Humanities	3 courses from 3 different areas (12)
BLOCK E − Lifelong Understanding Self-Development	1 course (4)

University Requirement (4 units) → 1 Course
Note: These are similar requirements as in the B.S. in Mechanical Engineering program.

ENGL 102	Composition II: Analytical and Persuasive Writing (4)
WPE	Writing Proficiency Exam (Prior to completing 135 quarter units**)** *Prerequisites*: ENGL 102

Lower Division Major Requirements (68-70 units) → 19 Courses

Math and Science (28):
Note: These courses could build a strong STEM foundation, up to early calculus and linear algebra levels that are required for most of practical engineering design tasks and that match the highest level of mathematics high school students could reach, for future K-12 engineering and technology teachers. Notice that, if necessary and possible, the pre-calculus level physics courses PHY 101, 102 and 103 could be changed to calculus-based PHYS 211, 212, and 213.

MATH 206	Calculus I: Differentiation (4) *Prerequisite: MATH 102 and 103.*
MATH 207	Calculus II: Integration (4) *Prerequisite: MATH 206*
ME 210S	Matrix Algebra for Engineers (4) *Prerequisite: MATH 207* (Note: This would be a special course that requires only Calculus I and II

	as pre-requisites, instead of MATH 208 – Calculus III - Sequences, Series, and Coordinate Systems)
PHYS 101	Mechanics (4) *Prerequisite: Knowledge of elementary algebra and trigonometry*
PHYS 102	Waves, sound, fluids, thermal physics, kinetic (4) *Prerequisite: PHYS 101*
PHYS 103	Electricity and magnetism (4) *Prerequisite: PHYS 102*
CHEM101	General Chemistry I (4) *Prerequisite: HS CHEM & PHYS; 2 years of HS Algebra, Placement test*

K-12 Engineering and Technology Foundation (16):

Note: These courses could offer future K-12 engineering and technology teachers the competency to teach K-12 appropriate engineering and technology foundation courses (for middle and high schools); and could be considered as "light versions" of typical lower-division general engineering courses, but based on pre-calculus mathematics.

ENGR 100	Introduction to Engineering (1) *Prerequisite: NONE*
TECH 110	Introduction to Drafting (3) *Prerequisite: NONE* (Note: AutoCAD would be used to teach drafting projection theory)
TECH (N 1)	**High School Engineering: Statics and Dynamics (4)** *Prerequisite: Math 206 and 207, PHYS 101* (Note: Lab experiments included)
TECH (N 2)	**High School Engineering: Strength of Materials & Material Selection (4)** Prerequisite: *TECH (N 1) and CHEM 101* (Note: Lab experiments included)
TECH 250	Impact of Technology on the Individual and Society (4) *Prerequisite: NONE*

K-12 Engineering and Technology Curriculum Development (12):

Note: These courses could offer future K-12 engineering and technology teachers the competency to design K-12 appropriate engineering and technology curriculum (throughout K-12); to apply digital technology in teaching of knowledge content and in classroom organization; and to manage programs and facilities.

TECH 101	Industrial Safety for Industrial Education (3) *Prerequisite: NONE*
TECH 130	Introduction to Graphic Communications (3) *Prerequisite: NONE*
TECH (N 3)	**Digital Simulation for K-12 Engineering & Technology (3)** *Prerequisite: TECH (N 2)*
TECH (N 4)	**Creative Activities for Engineering and Tech Teachers (3)** *Prerequisite: None*

High School Engineering and Technology Option (12-14):

Note: These courses could offer future K-12 engineering and technology teachers the competency to teach "Career Pathways" engineering and technology "major" courses at high schools, helping high school students with focused studies of engineering subjects;

and could be considered as "light versions" of typical lower-division engineering major courses, but based on pre-calculus mathematics.
Students could choose one from the following options.

Mechanical Design Option (12):

TECH (N 5)	3D Parametric Solid Modeling and Design (3) *Prerequisite: TECH 110* (Note: Inventor or SolidEdge would be used)
EE 204S	Circuit Analysis (4) *Prerequisite: PHYS 103 (*Note: This would be a special course that requires only PHYS 103 as pre-requisite, instead of PHYS 213 - Electricity and Magnetism)
TECH 144	Introduction to Industrial Design (3) *Prerequisite: TECH 110 and Concurrent enrollment with TECH (N 5)* (Note: The pre-requisites are added to make the course more meaningful)

Manufacturing System Option (12):

TECH 160	Introduction to Metalworking (3) *Prerequisite: NONE*
TECH 261	Sheet Metal Layout and Development (3) *Prerequisite: TECH 160* (Note: Inventor would be used)
TECH 144	Introduction to Industrial Design (3) *Prerequisite: TECH 110 and Concurrent enrollment with TECH (N 5)* (Note: The pre-requisites are added to make the course more meaningful)

Electrical and Electronics Option (13):

TECH 120	DC Electronics (3) *Prerequisite: NONE*
TECH 221	AC Electronics (3) *Prerequisite: TECH 120*
EE 204S	Circuit Analysis (4) *Prerequisite: PHYS 103 (*Note: This would be a special course that requires only PHYS 103 as pre-requisite, instead of PHYS 213 - Electricity and Magnetism)

Civil Engineering and Construction Option (14):

CE 202	Plane Surveying (4) *Prerequisite: MATH 103 – Algebra & Trigonometry*
CE 195S	Civil Engineering Design I (4) *Prerequisite: CE 202, PHYS 101, TECH 110* (Note: This would be a special course that requires only PHYS 101 and TECH 110 as pre-requisites, instead of PHYS 211 and CE 190)
TECH 170	Introduction to Wood Technology (3) *Prerequisite: NONE*
TECH 271	Wood Construction Technology I (3) *Prerequisite: TECH 170*

Upper Division Major Requirements (41 Units) → 15 Courses

K-12 Engineering and Technology Teacher Education (26):
Note: These courses could offer future K-12 engineering and technology teachers the competency to teach K-12 students as effective educators able to interact with students

of diverse economic and cultural backgrounds in the State of California; and could be considered as the specific versions of typical K-12 teacher training courses designed for engineering and technology curriculum.

EDFN 440	Schooling for a Diverse, Urban Society (4) *Prerequisite: NONE*
TECH 384	Foundations of' Technology Education (4) *Prerequisite: NONE*
TECH (N 6)	**Computer Applications for Teachers (3)** *Prerequisite: NONE*
TECH 491	Technology Education in the Middle Grades (4) *Prerequisite: TECH 384*
TECH 492	Technology Education in the High School (4) *Prerequisite: TECH 384*
TECH 493	Technology Education Facilities: Planning, Construction, Equipment, and Maintenance (3) *Prerequisite: TECH 384*
TECH 494	Industrial and Technology Education Curriculum (4) *Prerequisite: TECH 384*
TECH (N 7)	**Practicum in K-12 Engineering and Tech Education I (2)** *Prerequisite: Senior year standing* (Note: Half of this course would cover the topics of TECH 483AB - Construction of Teaching Aids)
TECH (N 8)	**Practicum in K-12 Engineering and Tech Education II (2)** *Prerequisite: TECH (N 7)*

Upper Division General Engineering and Technology (15):

Note: These courses could offer future K-12 engineering and technology teachers the competency to teach K-12 appropriate engineering and technology foundation courses at high schools; and could be considered as "light versions" of typical upper-division engineering and technology courses, but based on pre-calculus mathematics.

TECH 310	The Design Process (3) *Prerequisite: NONE*
ENGR 300	Economics for Engineers (4) *Prerequisite: NONE*
TECH 370	Power, Energy and Transportation (3) *Prerequisite: NONE*
TECH 360	Modern Manufacturing (3) *Prerequisite: NONE*
TECH 454LP	Special Topics in Industrial Studies (1) *Prerequisite: Upper division standing; others as needed for specific topic*
TECH 499	Undergraduate Directed Study (1) *Prerequisite: Consent of an instructor to act as sponsor.*

Upper Division Engineering and Technology Options (24-25) → 6 Courses

Note: These courses could offer future K-12 engineering and technology teachers the competency to teach "Career Pathways" engineering and technology "major" courses at high schools, preparing high school graduates for a streamlined transition into college-level engineering majors; and could be considered as "light versions" of typical upper-division engineering major courses, but based on pre-calculus mathematics.

Each student would choose one Option which includes (1) Required Courses (16-20 units, or 4-5 courses); (2) Elective Courses (select 4-9 units, or 2-3 courses from the list). Choose one from the following option.

Mechanical Design Option (24):

Required Courses:

TECH (N 9A) **High School Engineering: Fluid Mechanics & Aerodynamics (4)**
Prerequisite: TECH (N 1) (Note: Lab experiments included) OR

TECH (N 9B) **High School Engineering: Heat Transfer & Thermodynamics (4)**
Prerequisite: *TECH (N 1)* (Note: Lab experiments included)

TECH (N 10) **High School Engineering: Mechanism Design & Selection I (4)**
Prerequisite: TECH (N 3)

TECH (N 11) **High School Engineering: Mechanism Design & Selection II (4)**
Prerequisite: TECH (N 10)

TECH 313 Product Deign and Development (3) *Prerequisite: TECH 310*

Elective Courses:

TECH 488 Fluid Power (3) *Prerequisite: PHYS 103* (Note: Prerequisite changed from PHYS 150 to PHYS 103)

TECH 484 Automated Manufacturing Systems (3) *Prerequisite: NONE*

TECH 411 Tool Design (3) *Prerequisite: TECH 110*

TECH 315 Project Design and Document Control (3)
Prerequisites: TECH 310 and 313.

TECH 312 Technical Illustration (3)
Prerequisite: TECH 110.

TECH 412 Manufacturing and Construction Drafting (3)
Prerequisite: TECH 110.

TECH 470 Electric, Hybrid and Alternative Fueled Vehicles (3)
Prerequisites: TECH 370 or with consent of instructor.

TECH 474 Power Generation, Distribution and Utilization (3)
Prerequisite: TECH 370 or with consent of instructor.

TECH 476 Electronic and Computer Control Systems for Power, Energy and Transportation (3)
Prerequisite: TECH 370 or with consent of instructor.

TECH 478 Emerging Technologies in Power, Energy & Transportation (3)
Prerequisite: TECH 370 or with consent of instructor.

TECH 414 Robotics in Industry (2)
Prerequisite: Upper division or graduate standing.

TECH 382 Power Technology (3) *Prerequisite: NONE*

Manufacturing System Specialty Option (24):

Required Courses:

TECH 484 Automated Manufacturing Systems (3) *Prerequisite: NONE*
(Note: MasterCAM would be taught in this course)

TECH 448 Plastics Technology (3) *Prerequisite: NONE*

TECH 490M Metal Technology (4) *Prerequisite: NONE*

TECH 490W Wood Technology (4) *Prerequisite: NONE*

Elective Courses:

TECH 461 Molding and Casting (3) *Prerequisite: TECH 160*

TECH 382 Power Technology (3) *Prerequisite: NONE*
TECH 313 Product Deign and Development (3) *Prerequisite: TECH 310*
TECH 411 Tool Design (3) *Prerequisite: TECH 110*
TECH 412 Manufacturing and Construction Drafting (3) *Prerequisite: TECH 110.*
TECH 160 Introduction to Metalworking (3)
TECH 462 Digital Manufacturing (3) *Prerequisite:*
TECH 460 Manufacturing, Materials, and Processes (3) *Prerequisite: TECH 360*
TECH 361 Welding Technology (3) *Prerequisite: TECH 160*
TECH 362 Heat Treating and Metallurgy (3) *Prerequisite: TECH 160*
TECH 462 Digital Manufacturing (3) *Prerequisites: TECH 360, and 460*
TECH 463 Metal Machining I (3) *Prerequisite: TECH 160*
TECH 464 Metal Machining II (3) *Prerequisite: TECH 160*
TECH 465 Automated Metal Machining (3) *Prerequisite: TECH 160.*
TECH 466 Computer-Aided Manufacturing (3) *Prerequisites: TECH 360, 460, 462*
TECH 467 Emerging Manufacturing Technologies (3) *Prerequisite: Prerequisites: TECH 360, 460, 462, 466*
TECH 414 Robotics in Industry (2) *Prerequisite: Upper division or graduate standing*

Electrical and Electronics Option (24):

Required Courses:

TECH 321 Solid State Electronics (3) *Prerequisite: TECH 221*
TECH 326 Digital Electronics (3) *Prerequisite: TECH 321*
TECH 428 Computer Assisted Design (CAD) in Printed Circuit Board (PCB) Design and Manufacturing (3) *Prerequisite: TECH 326* (Note: ElectricalWorkbench or PSpice recommended for CAD)
TECH 470 Electric, Hybrid and Alternative Fueled Vehicles (3) *Prerequisites: TECH 370 or with consent of instructor.*

Elective Courses:

TECH 474 Power Generation, Distribution and Utilization (3) *Prerequisite: TECH 370 or with consent of instructor*
TECH 415 Electromechanical Drafting and Design (3) *Prerequisite: TECH 110, 120*
TECH 323 Industrial Electronics (3) *Prerequisite: TECH 321*
TECH 324 Linear Electronics (3) *Prerequisite: TECH 321*
TECH 325 Industrial Controls (3) *Prerequisite: TECH 321*
TECH 382 Power Technology (3) *Prerequisite: NONE*
TECH 414 Robotics in Industry (2) *Prerequisite: Upper division or graduate standing*
TECH 327 Microprocessors (3) *Prerequisite: TECH 326.*

Civil Engineering and Construction Option (24):

TECH (N 12)	**High School Structural Mechanics and Design (4)** *Prerequisite: TECH (N 2)*
TECH (N 14)	**High School Concrete Laboratory & Computer Simulation (4)** *Prerequisite: TECH (N 12)*
CE 352	Technological Aspects of Urban Environment (4) *Prerequisites: Completion of Basic Subjects (Block A) and one course from Block B.*
TECH 311	Architectural Drafting I (3) *Prerequisite: TECH 110* (Note: Architectural Desktop or Revit are recommended for CAD)

Elective Courses:

TECH 413	Architectural Drafting II (3) *Prerequisite: TECH 311* (Note: Architectural Desktop or Revit are recommended for CAD)
TECH 478	Emerging Technologies in Power, Energy & Transportation (3) *Prerequisite: TECH 370 or with consent of instructor.*
TECH 312	Technical Illustration (3) *Prerequisite: TECH 110*
TECH 488	Fluid Power (3) *Prerequisite: PHYS 103* (Note: Prerequisite changed from PHYS 150 to PHYS 103)
TECH 372	Wood Finishing and Preservation (3) *Prerequisite: TECH 170*
TECH 374	Wood Shaping Processes (3) *Prerequisite: NONE*
TECH 471	Lamination, Forming, Bonding (3) *Prerequisite: TECH 170*
CE 358	Environment, Earth Systems and Technology (4) (also listed as GEOG 358) *Prerequisites: Completion of Basic Subjects (Block A) and one course from Block B*
CE 475	Advanced Surveying (4) *Prerequisite: CE 202*

Laboratory Electives (1 unit) → 1 Course

Note: These courses could offer future K-12 engineering and technology teachers more advanced skills and competency for teaching high school engineering and technology "Career Pathway" students laboratory experiments and digital simulations; and could be considered as specialized versions of typical upper-division engineering Laboratory Elective courses.

TECH (N 15)	**Advanced High School Strength of Materials Lab (1)**
TECH (N 16)	**Advanced High School Fluid Mechanics and Aerodynamics Lab and Simulation (1)**
TECH (N 17)	**Advanced High School Computer-aided-design (1)**
TECH (N 18)	**Advanced High School Engineering and Technology Digital Simulation Lab (1)**

Senior Year Engineering Design (12) → 3 Courses

Note: These courses could offer future K-12 engineering and technology teachers the competency to design functional engineering projects (such as industrial products with simple mechanical and electronic components, or alternative energy systems for household and community applications); to teach K-12 students engineering and technology design processes, including: (1) Conceptual or creative design for

kindergarten and elementary school pupils; (2) Engineering experiments and design for middle school students; (3) "Analytic Reduction" engineering design model for regular high school engineering and technology courses; and (4) "Systems Thinking" engineering design model for graduation year high school students enrolled in "capstone" engineering "Career Pathway" courses. These courses could help future K-12 engineering and technology teachers to prepare professional design portfolios, for demonstration to high school students; and could be considered as "special versions" of typical upper-division engineering Senior Design courses.

TECH (N 19A) **K-12 Engineering Design Senior Project I (4)** *Prerequisite: Completion of all lower division High School Engineering and Technology Option courses, plus junior year standing.*

TECH (N 19B) **K-12 Engineering Design Senior Project II (4)**
Prerequisite: TECH (N 19)

TECH (N 19C) **K-12 Engineering Design Senior Project II (4)**
Prerequisite: TECH (N 20)

General Education Upper Division Theme (12 units) → 3 Course

Note: These courses could offer future K-12 engineering and technology teachers broad knowledge about and systemic understanding of some of the most important issues facing the United States and the whole world, with strategic significance for the future of mankind, such as Globalization (economic, political, scientific and technological), ecological sustainability and sustainable economic development, and cultural diversity among the nations; and they could help educate future generations of innovative engineers and technologists with social-ecological consciousness.

Upper Division GE Theme: 3 courses (12)

All three GE courses must be at upper-division level. The following courses would be recommended:

- Gender in the Diversity of Human Experience;
- Any course on the issue of Globalization;
- Any course related to environmental protection.

APPENDIX 1-F-2

New Course Descriptions For the Proposed Bachelor of Science in K-12 Engineering and Technology Teacher Education

FOR CALIFORNIA STATE UNIVERSITY, LOS ANGELES

(Note: All notes to be deleted after the course descriptions are finalized and approved)

Lower Division Major Requirements

K-12 Engineering and Technology Foundation:

TECH (N 1) High School Engineering: Statics and Dynamics (4)
Prerequisite: Math 206 and 207, PHYS 101 (Note: Lab experiments included)
This course would explore the fundamental engineering principles and methods of statics and dynamics, and connects class concepts and knowledge with community-based problems. Topics might include: Statics Part: General principles (mechanics, concepts, units of measure, numerical calculations), force vectors (scalars and vectors), equilibrium of a particle, free-body diagram, coplanar force systems, resolution and composition of forces, equilibrium of a rigid body, structural analysis and internal forces. Dynamics Part: kinematics of a particle (work and energy, impulse and momentum), planar kinematics of a rigid body (force and acceleration).
Note: This would be the first in a series of high school appropriate mechanical engineering courses that are based on pre-calculus mathematics with a slight inclusion of early calculus (integration and differentiation). This course description has drawn reference from the course descriptions of (1) UGA ETES 5090 - Principles of Technology (http://bulletin.uga.edu/bulletin/courses/descript/etes.html); and (2) CSULA ME 201 Statics and ME 320 Dynamics
I (http://www.calstatela.edu/academic/ecst/me/courses.php); as well as from course syllabus of Dr. John Mativo, Professor of Engineering at the College of Education, University of Georgia (UGA).

TECH (N 2) High School Engineering: Strength of Materials & Material Selection (4)
Prerequisite: *TECH (N 1) and CHEM 101* (Note: Lab experiments included)
This course would explore the fundamental principles and methods of strength of materials and material science, and connects class concepts and knowledge with industry-based problems. Topics might include: Strength of Materials Part: Stress and strains under axial, shearing, and torsional forces; flexural stresses and deflections of simple beams; columns; and combined stresses. Material Selection: Structure and fundamental atomic and molecular mechanisms of engineering materials, atom and electron movement, physical and mechanical properties; production and treatment of metals, alloys, polymers,

ceramics and composites, and semiconductor materials; and material selection and protection against deterioration, environmental effect on material behavior, recyclability, and aesthetics concern. Material testing lab projects are included. Material selection through the Internet would be covered.
Note: This would be the second in a series of high school appropriate mechanical engineering courses that are based on pre-calculus mathematics with a slight inclusion of early calculus (integration and differentiation). This course is designed to offer K-12 Engineering and Technology Teacher Education students high school appropriate analytic and predictive skills in the subject of strength of materials, as well as basic knowledge and skills covered in a material science course in selecting and testing materials used in engineering design. This course description has drawn references from relevant engineering course descriptions from the University of Georgia (ENGR 2140 - Strength of Materials and ENGR 6370 - Material Science, at http://bulletin.uga.edu/bulletin/courses/descript/engr.html) and California State University Los Angeles (ME 205 - Strength of Materials I, ME 208 - Statics and Strength of Materials, ENGR 207 - Materials Science and Engineering, and ME 430 - Properties and Selection of Engineering Materials, at http://www.calstatela.edu/academic/ecst/me/courses.php, and http://www.calstatela.edu/centers/SCCEME/engr207.htm).

K-12 Engineering and Technology Curriculum Development:

TECH (N 3) Digital Simulation for K-12 Engineering & Technology (3)
Prerequisite: TECH (N 2)
This course would cover the topics and skills of digital simulation software for engineering analysis and design, such as FoilSim (http://www.grc.nasa.gov/WWW/K-12/FoilSim/index.html; for aerodynamic), RocketModeler (http://www.grc.nasa.gov/WWW/K-12/rocket/rktsim.html, for principles of weight, thrust, aerodynamic forces, lift and drag, etc..), West Point Bridge Designer (http://bridgecontest.usma.edu/, for bridge design), Yenka (http://www.yenka.com/en/Yenka_Gears/, for electronics PCB simulation, gears set design, statistics modeling, and others), and others that are appropriate for K-12 students. This course would be hands-on.
Note: This is a proposed course description written by Edward Locke.

TECH (N 4) Creative Activities for Engineering and Technology Teachers (3)
Prerequisite: None
This course is designed to teach K-12 Engineering and Technology Teacher Education students how to conduct Internet and library search, to find relevant information of science, engineering and technology under the four major systems of technology: (1) construction; (2) mechanical; (3) communication; and (4) transportation; to design instructional plan and materials, including plans of instruction, teachers' report, learning materials, PowerPoint presentation, QuickTime or PhotoStory movies, engineering notebooks, engineering design sketches, scaled model construction. Pedagogy includes demonstration and hands-on learning, problem solving, designing, construction, and

testing of prototypes, and activities that increase aesthetic, psychomotor, and cognitive development.
Note: Edward Locke taught this course at UGA (ETES 2320-2320L - Creative Activities for Teachers Laboratory)

High School Engineering and Technology Option:

Mechanical Design Option:

TECH (N 5) 3D Parametric Solid Modeling and Design (3)
Prerequisite: TECH 110
This course would cover three-dimensional modeling of products with simple mechanical components and assemblies, and creation of two-dimensional working drawings (orthographic and isometric), and presentation drawings (assembly and explosion), with parametric computer-aided drafting (CAD) software (SolidEdge, SolidWorks or Inventor). A semester design project would be required.
Note: This is a new course description.

Upper Division Major Requirements

K-12 Engineering and Technology Teacher Education:

TECH (N 6) Computer Applications for Teachers (3)
Prerequisite: NONE
This course would cover various software used in the delivery and management of K-12 instruction. Topics might include: Computer and its educational applications for pre-service teachers; computer-based education in the areas of instruction, text and data processing, multimedia, and telecommunications. Emphasis on integrating computer tools into class instruction. Software to be explored might include Microsoft Office, Blackboard, QuickTime and PhotoStory Movies and others.
Note: This course description is based on UGA EDIT 2000 - Introduction to Computers for Teachers.

TECH (N 7) Practicum in K-12 Engineering and Technology Education I (2)
Prerequisite: Senior year standing
Initial supervised field experience related to teaching individuals in programs of K-12 engineering and technology education. The emphasis is on appropriate pedagogy for K-12 engineering and technology curriculum, including design and construction of teaching aids, selection and preparation of instructional materials, classroom management, and others.
Note: Half of this course would cover the topics of TECH 483AB - Construction of Teaching Aids in CSULA Catalog.

TECH (N 8) Practicum in K-12 Engineering and Technology Education II (2)
Prerequisite: TECH (N 7)

This is the second course on supervised field experience related to teaching individuals in programs of K-12 engineering and technology education. Projects might include: Observation and participation experience in a school setting; classroom teaching and student performance evaluation, and others. The emphasis would be on classroom management.

Upper Division Engineering and Technology Options

Mechanical Design Option:

TECH (N 9A) High School Engineering: Fluid Mechanics and Aerodynamics (4)
Prerequisite: *TECH (N 1)* (Note: Lab experiments included)
This course would include two parts. Fluid Mechanics Part: The fundamental engineering principles and methods of fluid mechanics, with an emphasis on their applications in boat, airplane, barometer and other practical designs. Topics include elements and engineering applications of the laws of fluid behavior to evaluate the forces and energies generated by fluids at rest and in motion. Aerodynamics Part: Air-foil characteristics; transonic, supersonic, and viscous effects on lift and drag; power considerations, airplane performances. AirFoil and other K-12 appropriate simulation software might be used.
Note: This would be the third in a series of high school appropriate mechanical engineering courses that are based on pre-calculus mathematics with a slight inclusion of early calculus (integration and differentiation). This new course is designed to offer K-12 Engineering and Technology Teacher Education students high school appropriate analytic and predictive skills in the subject of fluid mechanics and aerodynamics. The description has drawn reference from relevant engineering course descriptions at the University of Georgia (ENGR 3160 - Fluid Mechanics, at http://bulletin.uga.edu/bulletin/courses/descript/engr.html) and California State University Los Angeles (ME 303 - Fluid Mechanics I, and ME 403 Aerodynamics, available at http://www.calstatela.edu/academic/ecst/me/courses.php).

TECH (N 9B) High School Engineering: Heat Transfer and Thermodynamics (4)
Prerequisite: TECH (N 1) (Note: Lab experiments included)
This course would include two parts. Heat Transfer Part: Fundamental principles of heat transfer; conduction, convection, and radiation; and applications. Thermodynamics Part: The fundamental engineering principles and analytic methods of thermodynamics, with an emphasis on their applications in energy conversion, usage and efficiency. Topics might include: Concepts of equilibrium and temperature; first and second laws of thermodynamics, properties of pure substances; ideal gases; application of thermodynamic principles to closed and open systems, forms of energy, transformations of energy, and energy flows and their applications in engineering systems, such as steam generators, engines and turbines; combustion, vapor cycles; refrigeration; internal combustion engines.
Note: This would be the fourth in a series of high school appropriate mechanical engineering courses that are based on pre-calculus mathematics with a slight inclusion of early calculus (integration and differentiation). This new course is designed to offer K-12

Engineering and Technology Teacher Education students high school appropriate analytic and predictive skills in the subject of heat transfer and thermodynamics. The description has drawn reference from relevant engineering course descriptions at the University of Georgia (ENGR 3140 - Thermodynamics, at http://bulletin.uga.edu/bulletin/courses/descript/engr.html) and California State University Los Angeles (ME 306 Heat Transfer I, and ME 326A - Thermodynamics I, at http://www.calstatela.edu/academic/ecst/me/courses.php).

TECH (N 10) High School Engineering: Mechanism Design and Selection I (4)
Prerequisite: TECH (N 3)
This course would cover design and selection of mechanical elements and components (such as gears and cams, pulleys, wheels and axles, screws and fasteners and locking devices, linkages, shafts, springs, and others), application of principles of mechanics (kinematics analysis of mechanisms, tolerance and interference, and others), and properties of materials, and manufacturing processes. The emphasis is on the design of simple mechanical parts and selection of out-of-shelf mechanical elements and components in the design of products and equipments. Basic analytic formulas appropriate to high school students would be covered.
Note: This would be the fifth in a series of high school appropriate mechanical engineering courses that are based on pre-calculus mathematics with a slight inclusion of early calculus (integration and differentiation). This would be the first course in high school appropriate mechanism design and selection. The description has drawn reference from relevant engineering course descriptions at the University of Georgia (ENGR 3300 - Mechanisms and Machine Kinematics, at http://bulletin.uga.edu/bulletin/courses/descript/engr.html), and California State University Los Angeles (ME 323 - Machine Design I, at http://www.calstatela.edu/academic/ecst/me/courses.php).

TECH (N 11) High School Engineering: Mechanism Design and Selection II (4)
Prerequisite: TECH (N 10)
This course would cover similar topics as in the TECH (N 10) High School Engineering: Mechanism Design and Selection I, with an emphasis on practical mechanism design, and an additional topics of mechanism design in CAD (Inventor, or SolidWorks, or SolidEdge) and digital simulation (COSMOSWorks, etc.).
Note: This would be the sixth in a series of high school appropriate mechanical engineering courses that are based on pre-calculus mathematics with a slight inclusion of early calculus (integration and differentiation), and the second course in high school appropriate mechanism design.

Civil Engineering and Construction Option:

TECH (N 12) High School Engineering: Structural Mechanics and Design (4)
Prerequisite: TECH (N 2)
This course would cover various topics related to structures, with an emphasis on practical design. Topics might include: Structural Mechanics Part: Analysis of

determinate structures such as beams, frames, and cables, introduction to influence lines and analysis of indeterminate structures. Structural Design Part: Design of simple beams, columns and tension members made from steel, concrete, and timber; design of steel structures. The emphasis is on the characteristic of different types of structures and their practical applications. High school appropriate engineering analytic skills, digital simulation, and simple design project could be included.
Note: This would be the fifth in a series of high school appropriate civil engineering courses that are based on pre-calculus mathematics with a slight inclusion of early calculus (integration and differentiation), and the first course in high school appropriate civil engineering design. The description have drawn reference from relevant engineering course descriptions at California State University Los Angeles (CE 360 - Structural Mechanics I, CE 361 - Introduction to Structural Design, CE 382 - Computer Aided Structural Analysis, Design and Experimentation Laboratory, and CE 461 - Design of Steel Structures, available at http://www.calstatela.edu/academic/ecst/me/courses.php).

TECH (N 14) High School Concrete Laboratory and Computer Simulation (4)
Prerequisite: TECH (N 12)
This course would cover various aspects of strength design of reinforced concrete structures, beams, slabs, frames, columns, footings, and retaining walls, including lab experiment (physical tests of cement, concrete aggregates, tensile strength test of cement, proportioning of concrete mixtures, slump test, compressive and flexural strength tests), a simple design and construction project, as well as digital simulation with structural analysis software might be included.
Note: This would be the second in a series of high school appropriate civil engineering courses that are based on pre-calculus mathematics with a slight inclusion of early calculus (integration and differentiation), and the second course in high school appropriate civil engineering design. The description has drawn reference from relevant engineering course descriptions at California State University Los Angeles (CE 364 Concrete Laboratory, CE 462 - Reinforced Concrete Design I, and CE 382 - Computer Aided Structural Analysis, Design and Experimentation Laboratory, at http://www.calstatela.edu/academic/ecst/me/courses.php).

Laboratory Electives

TECH (N 15) Advanced High School Strength of Materials Lab (1)
Prerequisite: Completion of TECH (N 2) plus junior year standing, and approval from instructor.
This course would offer additional lab experiment opportunities for the subject of strength of materials, beyond those covered under TECH (N 2) - High School Engineering: Strength of Materials & Material Selection. Topics might include: Tests of engineering materials in tension, compression, bending, and torsion; verification by experiment of basic theories learned in strength of materials; preparation of metallic samples and study of their internal structure by microscopic techniques. Mechanical testing of non-metallic materials: plastics, ceramics and composites.

Note: The description of this course has drawn reference from relevant engineering course descriptions at California State University Los Angeles (ME 431 Material Laboratory, and ME 312 - Strength of Materials Laboratory I, at http://www.calstatela.edu/academic/ecst/me/courses.php).

TECH (N 16) Advanced High School Fluid Mechanics and Aerodynamics Lab and Simulation (1)
Prerequisite: Completion of TECH (N 3) and TECH (N 9A) plus junior year standing, and approval from instructor.
This course would offer additional lab experiment and/or digital simulation opportunities for the subject of fluid mechanics and aerodynamics, beyond those covered under TECH (N 9A) - High School Engineering: Fluid Mechanics and Aerodynamics. Simulation software might include: FoilSim (http://www.grc.nasa.gov/WWW/K-12/FoilSim/index.html) and FlowLab (http://www.cfd-online.com/Forum/news.cgi/read/865).
Note: This is a new course description proposed by Edward Locke.

TECH (N 17) Advanced High School Computer-aided-design (1)
Prerequisite: Completion of TECH (N 5) plus junior year standing, and approval from instructor.
This course would offer additional learning opportunities for the subject of computer-aided-design using parametric solid modeling software (Inventor, SolidWorks, SolidEdge, or CATIA), beyond those covered under TECH (N 5) - 3D Parametric Solid Modeling and Design.
Note: This is a new course description proposed by Edward Locke.

TECH (N 18) Advanced High School Engineering and Technology Digital Simulation Lab (1)
Prerequisite: Completion of TECH (N 3) plus junior year standing, and approval from instructor.
This course would offer additional learning opportunities for high school appropriate science and engineering simulation software, beyond those covered under TECH (N 3) - Digital Simulation for K-12 Engineering & Technology. Additional software to be used might include MathCAD, structural analysis, simulation and design software covered in CE 382 - Computer Aided Structural Analysis, Design and Experimentation Laboratory and others.
Note: This is a new course description proposed by Edward Locke.

Senior Year Engineering Design

TECH (N 19ABC) K-12 Engineering Design Senior Project I, II and III (4, 4, 4)
Prerequisite: Completion of all lower division High School Engineering and Technology Option courses, satisfactory completion of the graduation writing assessment requirement (GWAR), completion of or concurrent enrollment in all Required Courses under Upper

Division Engineering and Technology Options, senior year standing, and/or consent of the instructor.

This would be a sequence of three Senior Year Engineering courses to be taken in sequence starting with TECH (N 19A).

TECH (N19A): This course is designed to train future K-12 engineering and technology instructors to teach engineering design at middle school level, under the proposed model of infusion engineering design into K-12 curriculum. This course would cover studies of engineering design and experiment processes (including K-12 Technology Education Design Process, Engineering Design Process, and NCETE K-12 Engineering Design Process). Topics might include: Identification of major components of the engineering design process; review of fundamentals of engineering (statics, dynamics, and thermodynamics); development of engineering design strategies that incorporate creativity in engineering based problems; analysis of engineering design solutions based on ISO 9000 design criteria; case studies of typical engineering design problems (in mechanical, manufacturing, electrical and civil engineering fields), the impact of design constraints (scientific, technological, economic, environmental, health and safety, social, political, sustainability, constructability, and ethical and other factors); planning and designing of typical engineering project as encountered in practice; integration and synthesis of acquired knowledge under given constraints; establishment of engineering design principles and criteria to guide and to evaluate the design process; collection of data and samples through market/project visitation, Internet, library and patent search; generation of alternative solutions through individual and group "brainstorming" sessions; usage of engineering notebook; writing of preliminary report and oral presentation; construction of prototypes; connecting class concepts and knowledge with community-based problems, and integration of engineering applications into the engineering and technology education curriculum. This course would feature: (1) One K-12 appropriate engineering experiment for solving technological problems through the analysis and implementation of technical research and experimentation methods. (2) Two simple engineering design projects with well-structured and well-defined problems, with a focus on creativity, resourcefulness, and the ability to visualize and think abstractly. The focus is on using "analytic reduction" model to solve engineering design problems from the scientific and technological perspectives.

TECH (N19B) and TECH (N19C): These two courses are designed to train future K-12 engineering and technology instructors to teach engineering design at high school level, under the proposed model of infusion engineering design into K-12 curriculum. These two courses would feature the selection and completion of a faculty-supervised, complex engineering design project with ill-structured, ill-defined and open-ended problems, similar to typical problems encountered in engineering practice, and resulting in a formal report and oral presentation. Students will complete the projects with a comprehensive portfolio featuring engineering design notebook, research report, final design report (memoranda, computations, drawings, cost estimates etc.), working prototype or scaled models, CAD working drawings, and group oral presentation. These two courses continues to explore the same principles of engineering covered in TECH (N 19A), but with a focus on solving ill-structured engineering design problems, synthesizing and integrating all aspects of design ranging from scientific and technological to social and

ecological, leading to design solutions that are technologically functional, socially valuable, and ecologically sustainable; and integrating engineering applications into K-12 engineering and technology education curriculum.

Note: The descriptions of these courses have drawn reference from Dr. John Mativo's course syllabus and description for ETES 5110/7110 - Applications of Engineering in Technological Studies, and Dr. Robert Wicklein's ETES 5070/7070 - Research and Experimentation in Technological Studies at the University of Georgia (http://bulletin.uga.edu/bulletin/courses/descript/etes.html), and from the course descriptions at California State University Los Angeles (ME 497ABC - Mechanical Engineering Senior Project, from http://www.calstatela.edu/academic/ecst/me/courses.php; CE 495 - Civil Engineering Design Project and CE 496AB - Civil Engineering Design Project I and II, from http://www.calstatela.edu/academic/ecst/civil/courses.php; and EE 496ABC - Senior Design I, II and III, from http://www.calstatela.edu/academic/ecst/ee/courses.php).