



TEXAS TECH UNIVERSITY

Edward E. Whitacre Jr.  
College of Engineering

# Undergraduate Laboratory Renovation Initiative

The Whitacre College of Engineering Undergraduate Laboratory Renovation Initiative is a \$6.5MM effort to properly equip and modernize departmental teaching laboratories. This is an interdepartmental initiative to enhance the learning experience for all undergraduate students. By providing undergraduate students with modern equipment and aesthetically pleasing labs, these hands on teaching environments will better prepare our students for industry.

All of the undergraduate majors within the college participate in essential laboratory experiences as part of their curricular programs. An emphasis on laboratory-based team learning is consistent with the basic goals of the college. The industrial size and quality of laboratory and research equipment in the college facilitates this effort.

Keeping the college's extensive variety of equipment up-to-date with modern techniques and processes is not possible without industry support, as most engineering courses have a laboratory component. Texas Tech places a priority on undergraduate research and practical experiences in the classroom, which necessitates the need for state-of-the art equipment and modernization of many of the undergraduate labs.

## Initiative Laboratories

### Department of Chemical Engineering

Undergraduate Teaching Labs

### Department of Civil and Environmental Engineering

Environmental Engineering Teaching Laboratory  
Geotechnical Engineering Laboratory  
Structures Laboratory  
Mechanics of Fluids Laboratory  
Construction Materials and Mechanics of Solids

### Department of Electrical and Computer Engineering

ECE Undergraduate Laboratory  
Telecommunications and RF Laboratory  
Robotics, Controls & Mechatronics Laboratory  
Undergraduate Fabrication Facility  
Undergraduate Measurements Facility  
ELVIS II Labs  
Bioinstrumentation Lab  
MEMS Labs  
Optics & Photonics Lab  
Power Systems & Alternative Energy Lab  
Audiovisual, Studio & Collaborative Classrooms

### Department of Construction Engineering and Engineering Technology

Computer Labs

### Department of Industrial Engineering

Advanced Manufacturing Laboratory  
Ergonomics Laboratory

### Department of Mechanical Engineering

Mechanics and Materials Laboratory  
Dynamic Systems & Control Laboratory  
Machine Shop Laboratory  
Thermal Fluid Systems Laboratory





TEXAS TECH UNIVERSITY

Department of Chemical Engineering™

# Undergraduate Teaching Labs

## Undergraduate Laboratory Renovation Initiative

**LOCATION:**

**CHE B 005**

**SQUARE FOOTAGE:**

**1187 ft<sup>2</sup>**

**CONTACT:**

**Dr. Sindee Simon**

**EMAIL:**

**sindee.simon@ttu.edu**

**PHONE:**

**806.742.3553**

The Chemical Engineering Unit Operations Laboratories consists of transport, process control, and polymer labs.

These laboratories teach key components of manufacturing chemical and biological products in industry. The labs are dedicated to providing students with an understanding of how theory works in real life. Students get hands-on experience in running the lab/pilot scale equipment, taking samples and analyzing samples in modern instruments, and writing a detailed report.

The report includes statistical data analysis, design of experiments, and safety analysis in addition to the presentation of experimental results and discussions. All experiments are conducted in a group environment and students learn how to work in groups and manage a “project.”

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Micro-reactor for ChE 4232	\$35,000	The department has no experiments dealing with reaction engineering; this microreactor will not take any significant space but will provide hands-on experience to the juniors and seniors in this topic, which is essential for the understanding of Chemical Engineering. This will help with our next ABET accreditation.
2. a. Bioengineering laboratory for ChE 4232, 4363 and 4364 3-liter computer-controlled fermentation unit (Applikon)	\$40,000	The department has a minor in Bioengineering, however, it has no experimental set-up, which can help students to study topics in Biochemical Engineering.
b. Autoclave	\$15,000	This is essential equipment in any Bioengineering Program.
c. Spectrophotometer	\$10,000	
3. HPLC (Waters) for ChE 4232, 4363, 6364, 4385 and 3323	\$60,000	The department does not have any chromatographic equipment for any composition measurement. This instrument is essential for three labs.
4. Gas Chromatograph (HP) for ChE 4232, 4363, 6364, 4385 and 3323	\$60,000	The department undergraduate teaching lab has various experiments (e.g. Gas absorption) which require gas composition measurements. We currently have none of these instruments.
5. Dedicated Process Control Equipment and data acquisition for ChE 4153 and 4232	\$50,000	The Process Control Equipment in the UG teaching Labs is more than 25 years old. This needs to be replaced with a state of the art facility.
6. Automation of all the equipment in the UG Teaching Labs - ChE 3232, 4232 and 4253	\$70,000	All the experimental systems in Chemical Engineering Teaching Lab are old and do not have modern data acquisition and control capabilities. During the recent ABET visit, the evaluator expressed an opinion that this modernization would need to be accomplished before the next ABET visit.
7. Polymer and Soft Material Laboratory to be used in ChE 4344/5344 and also in ChE 4232 and 3232		
a. Miniextruder ChE 4344/5344	\$25,000	
b. Tensile Tester ChE 4344/5344	\$30,000	
c. Industrial Rheometer ChE 4344/5344	\$40,000	
d. Melt Indexer	\$20,000	
e. Optical Microscope with Hot Stage	\$20,000	
f. Scanning Electron Microscope	\$30,000	
g. Differential Scanning Calorimeter	\$35,000	
h. Fourier Transform Infrared Spectrometer	\$40,000	
i. Platen Press	\$15,000	
j. Microbalance	\$10,000	
<b>TOTAL ESTIMATED COST: \$605,000</b>		



# Environmental Engineering Teaching Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** CEE 025

**SQUARE FOOTAGE:** 194 ft<sup>2</sup>

**CONTACT:** Dr. H. Scott Norville

**EMAIL:** scott.norville@ttu.edu

**PHONE:** 806.742.1930

The Environmental Engineering Teaching Laboratory is a required laboratory class for both undergraduate and graduate civil and environmental engineering students.

Approximately 130 undergraduate and 30 graduate students use this lab each semester.

The primary purpose for this lab is demonstrating the principles of water and wastewater treatment processes.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Room Renovations	\$50,000	Necessary to support items 2 through 7
2. Vacuum Line for Filtration	\$20,000	Self explanatory
3. Milli-Q Water System	\$10,000	New system will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
4. Emergency Shower	\$1,000	Safety
5. Two (2) Additional Lab Benches	\$10,000	Congestion noted by ABET PEV.
6. New Acid Cabinet	\$500	Safety
7. Ventilation Hood and Ducting	\$17,000	Safety
8. Four (4) Rapid Mix Flocculators	\$12,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
9. Four (4) Spectrophotometers/Turbidity Meters	\$12,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
10. Eight (8) water quality multimeters with probes (DO/ORP/pH/T/TDS)	\$16,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
11. BOD Incubator	\$6,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
12. Total Organic Carbon/Total Nitrogen Analyzer	\$35,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
13. Integrated Type II Clarifier II	\$8,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
14. Activated Sludge Demonstration Unit	\$10,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
15. Centrifuge	\$8,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
16. Autoclave	\$12,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
17. Rotatry Shaker	\$8,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
18. Oven	\$1,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
19. High Performance Liquid Chromatograph	\$85,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
<b>TOTAL ESTIMATED COST: \$321,500</b>		



# Geotechnical Engineering Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** CEE 224, 226, 229

**SQUARE FOOTAGE:** 2321 ft<sup>2</sup>

**CONTACT:** Dr. H. Scott Norville

**EMAIL:** scott.norville@ttu.edu

**PHONE:** 806.742.1930

The Geotechnical Engineering Laboratory is used for soil sample preparation, characterization and strength tests, as well as consolidation tests and graduate research experiments.

This laboratory provides students with an understanding of the basic principles of controlling soil behaviors and familiarization of soil test procedures, as well as design procedures used in a general geotechnical engineering practice.

In addition to practical experience, students have an opportunity to improve technical writing skills.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. New Cabinets, Countertops and Sinks	\$40,000	Existing Items are not ADA compliant and are dated. ABET PEV expressed concern over the age of equipment.
2. Replace all teaching test equipment in Room 229	\$150,000	ABET PEV expressed concern over the age of equipment.
3. Triaxial Cell for GCTS Machine	\$20,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
<b>TOTAL ESTIMATED COST:</b>		<b>\$210,000</b>



# Structures Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** CEE 193

**SQUARE FOOTAGE:** 5138 ft<sup>2</sup>

**CONTACT:** Dr. H. Scott Norville

**EMAIL:** scott.norville@ttu.edu

**PHONE:** 806.742.1930

The Structures Laboratory provides undergraduate and graduate students a location for conducting large-scale experiments on structural members.

The facility includes support for welding, machining, woodworking, instrumentation, data collection, and hydraulics experiments.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Two (2) Concrete Compression Testing Machines	\$19,000	Existing machine is very old. ABET PEV commented on this.
2. Three (3) Small Material Weighing Scales	\$9,000	Supports construction materials courses.
3. New Concrete Mixer	\$4,000	Supports construction materials courses.
4. Precision TIG Welder and Associated Supplies	\$4,500	Supports steel bridge design class.
5. Large Capacity Materials Scale	\$1,300	Supports construction materials courses.
6. Vishay Strain Gage Data Collection System	\$60,000	New system will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
7. Materials Curing Oven	\$8,500	Existing oven is very old.
8. Ventilator Hood for Sieve Shaker plus Venting Ducts	\$17,000	Improves Air Quality for Students in Proximity, Potentially a Safety Issue
9. Two sets of MTS Hydraulic Actuator Systems (200 kips compression and 100 kip tension)	\$500,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
10. Data Acquisition System with NI Interface	\$15,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
11. Steel Reaction Frames	\$30,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.

**TOTAL ESTIMATED COST: \$668,300**



# Mechanics of Fluids Laboratory

## Undergraduate Laboratory Renovation Initiative

The Mechanics of Fluids Laboratory provides students with an understanding of the basic principles of controlling fluid properties; hydrostatics; pipe flow; pumping systems; open channel flow; conservation of mass, energy and momentum; as well as design procedures used in engineering practice.

**LOCATION:** CEE 178

**SQUARE FOOTAGE:** 583 ft<sup>2</sup>

**CONTACT:** Dr. H. Scott Norville

**EMAIL:** scott.norville@ttu.edu

**PHONE:** 806.742.1930

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Particle Imagery Velocimeter	\$150,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
2. Acoustic-Doppler Velocimeter	\$20,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
3. High Speed Cameras	\$75,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
4. New Teaching Flume	\$125,000	Will (if we move the fluids lab across the hall) remove some congestion in lab sessions. ABET PEV expressed concerns with respect to (a) the two flumes in the rather small room and (2) the congestion in having simply two flumes for the number of students CEE ran through the labs.
5. Basic Hydraulics Bench	\$10,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
6. Flow Meter Demonstration	\$8,000	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
7. Pressure Surge in Pipe and Water Hammer Apparatus	\$15,500	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
8. Centrifugal Pump Demonstration Unit	\$13,600	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
9. Series/Parallel Pump Demonstration Unit	\$22,500	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.
10. Interface Unit	\$8,200	New device will help to meet ABET Criterion 3(k): Ability to use modern engineering tools.

**TOTAL ESTIMATED COST: \$447,800**



TEXAS TECH UNIVERSITY

Department of Civil & Environmental Engineering™

# Construction Materials and Mechanics of Solids

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** CEE 029

**SQUARE FOOTAGE:** 1529 ft<sup>2</sup>

**CONTACT:** Dr. H. Scott Norville

**EMAIL:** scott.norville@ttu.edu

**PHONE:** 806.742.1930

The **Construction Materials Laboratory** teaches students how to determine and interpret the engineering properties of common construction materials. Students learn laboratory safety, material specifications, and testing methods, while developing their understanding of material properties by conducting relevant material property tests.

The **Mechanics of Solids Laboratory** enhances a student’s understanding of the mechanical properties of materials. Students develop or improve their skills in data collection, evaluation, and reporting results of laboratory experiments. Additionally, they design, conduct and present a group-specific experiment to demonstrate an assigned concept studied during the course.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Riehle Testing Machine	\$165,000	Existing machine is more than 60 Years old. ABET PEV commented on this.
2. Torsion Testing Machine	\$150,000	Existing machine no longer functions and cannot be repaired. ABET PEV commented on this.
<b>TOTAL ESTIMATED COST: \$315,000</b>		



# Undergraduate Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** ECE 007, 126, 127

**SQUARE FOOTAGE:** 6755 ft<sup>2</sup>

**CONTACT:** Dr. Michael Giesselmann

**EMAIL:** michael.giesselmann@ttu.edu

**PHONE:** 806.742.3533

The Electrical Computing Engineering Undergraduate Laboratory is utilized by several classes and provides a venue for undergraduate project work. The course-assigned projects use FPGAs (ECE 3331), microcontrollers (ECE 3332 / 3334), and communication electronics (ECE 3333) as the central components. The senior projects use a very wide variety of components. The laboratories provide testing and measurement equipment such as oscilloscopes, power supplies, meters, and analyzers. This equipment is necessary to produce and measure voltages, currents, and waveforms within student projects. The laboratories also provide circuit board manufacturing and assembly equipment such as soldering irons, microscopes, and ovens. The computer workstations provide access to supporting software such as schematic capture, board layout, compilers and assemblers, as well as datasheets and design assistance. The laboratories equip students with a solid foundation in electronic design and fault analysis.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. N9320B RF Spectrum Analyzer, 9 kHz to 3 GHz	\$8,500	The N9320B RF spectrum analyzer provides fast and easy measurements for consumer electronics manufacturing test applications. This spectrum analyzer offers fast measurement speed, best for mass production manufacturing tests, service and repair tasks. N9320B RF spectrum analyzer covers a frequency range from 9 kHz to 3 GHz, and is able to display four traces and 12 markers for easy analysis. It also provides a one-button power measurement suite and an optional tracking generator.
2. Tektronix MSO4104B	\$20,000	Mixed Signal 4 + 16 Digital
3. 10 lab bench stations for 1 hour labs, \$3000 each	\$30,000	(scope / power supply / meter / PC / breadboard)
<b>TOTAL ESTIMATED COST:</b>		<b>\$58,500</b>



TEXAS TECH UNIVERSITY

Department of Electrical & Computer Engineering™

# Telecommunications and RF Laboratory

## Undergraduate Laboratory Renovation Initiative

This lab allows students to measure and characterize signals commonly seen in telecommunications and RF applications. A section of one of the labs will be set up as a telecommunications and RF lab supporting hardware, including two PXI based RF measurements systems.

**LOCATION:** ECE 127

**SQUARE FOOTAGE:** 1893 ft<sup>2</sup>

**CONTACT:** Dr. Michael Giesselmann

**EMAIL:** michael.giesselmann@ttu.edu

**PHONE:** 806.742.3533

QTY	ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1	Agilent N9010 EXA Signal Analyzer	\$20,785	
1	Agilent N9038A MXE EMI Receiver	\$82,749	
1	Agilent N8973A Noise Figure Analyzer	\$42,785	
2	RF Measurements bundle for PXI (2)	\$105,000	

**TOTAL ESTIMATED COST: \$251,319**



TEXAS TECH UNIVERSITY

Department of Electrical & Computer Engineering™

# Robotics, Controls & Mechatronics Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** ECE 007

**SQUARE FOOTAGE:** 2987 ft<sup>2</sup>

**CONTACT:** Dr. Michael Giesselmann

**EMAIL:** michael.giesselmann@ttu.edu

**PHONE:** 806.742.3533

A robotics, controls, and mechatronics lab will be developed to serve the microcontroller/embedded systems project lab I and to support undergraduate robotics and embedded systems projects. New hardware platforms based on the DaNI robots will be purchased, giving the option of using the NI RIO interface. Computer vision stations, two robotic arm stations, and a controls station will be set up in the lab. An embedded systems lab will be developed to serve the EE and CMPE project labs as well as senior lab projects involving embedded systems and/or power. The lab includes curve tracers, two PXI systems with semiconductor test capabilities, and 8 cRIO embedded design platforms. This lab supports two senior level courses that have a project component, ECE 4316 and ECE XXXX. The c-RIO is a National Instruments platform that is widely used in industrial embedded systems applications and increases the marketability of our students.

QTY	ITEM DESCRIPTION	ESTIMATED COST	REMARKS
20	20 units at approximately \$2500 per unit	\$50,000	
	Computer vision smart camera systems	\$10,000	
8	C-RIO embedded design platform	\$75,000	
2	Tektronix 371b programmable curve tracer	\$70,000	
2	PXI embedded systems setup	\$70,000	
2	Robai humanoid manipulator arm – 2 limb x 2	\$18,000	
4	National Instruments Academic bundle for Quanser SRV-02 rotary control units x 4	\$36,000	
	Quanser systems	\$30,000	

**TOTAL ESTIMATED COST: \$359,000**



TEXAS TECH UNIVERSITY

Department of Electrical  
& Computer Engineering™

# Undergraduate Fabrication Facility

Undergraduate Laboratory Renovation Initiative

**LOCATION:** ECE 127  
**SQUARE FOOTAGE:** 1893 ft<sup>2</sup>  
**CONTACT:** Dr. Michael Giesselmann  
**EMAIL:** michael.giesselmann@ttu.edu  
**PHONE:** 806.742.3533

A new undergraduate fabrication lab will be developed, allowing for complete printed circuit board design, milling, and assembly. A 3d printer will allow for design of mechanical components to complement the robotics and mechatronics projects.

QTY	ITEM DESCRIPTION	ESTIMATED COST	REMARKS
	Complete Fabrication Lab	\$110,000	PCB milling stations LPKF - Automated S63 includes 10 licenses
1	3D Printer	\$20,000	
TOTAL ESTIMATED COST:			\$130,000



# Undergraduate Measurements Facility

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** ECE 127

**SQUARE FOOTAGE:** 1893 ft<sup>2</sup>

**CONTACT:** Dr. Michael Giesselmann

**EMAIL:** michael.giesselmann@ttu.edu

**PHONE:** 806.742.3533

This facility allows students to make basic measurements using state of the art modern equipment. Mixed signals are found in analog and digital systems today. This facility serves all of the undergraduate laboratories and ECE 3362, and allows for the visualization of signal in a complex mixed signals environment. Undergraduate measurements facility – 16 station measurement lab facility plus 3-4 stations of specialized equipment. The undergraduate measurements facility supports all levels of the labs, including the circuits and electronics labs, and provides standard measurement equipment and instrumentation.

QTY	ITEM DESCRIPTION	ESTIMATED COST	REMARKS
4	Spectrum Analyzers	\$48,000	
2	Curve Tracer	\$70,000	
	Mixed Signal Scopes (MSO5104) Tek	\$80,000	
16	200-400 MHz Oscilloscopes	\$32,000	
16	Power supplies	\$6,400	
16	Computers Stations	\$16,000	
16	Soldering Irons and miscellaneous tools	\$8,000	
4	Logic Analyzers or Mixed signal scopes	\$10,000	
16	Computer stations	\$12,800	

**TOTAL ESTIMATED COST: \$283,200**



TEXAS TECH UNIVERSITY

Department of Electrical & Computer Engineering™

# Bioinstrumentation Lab

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** ECE 007

**SQUARE FOOTAGE:** 2987 ft<sup>2</sup>

**CONTACT:** Dr. Michael Giesselmann

**EMAIL:** michael.giesselmann@ttu.edu

**PHONE:** 806.742.3533

This lab serves ECE 4333 and 4334 and is useful to students who do senior projects in the biomedical instrumentation and signal processing areas. Components include accelerometers for position and motion sensing to measure gait, etc., equipment to measure electrical signals from the heart, brain, and muscles, and eye tracking. A bioinstrumentation lab will serve senior lab students and undergraduate students taking the bioinstrumentation class (an interdisciplinary class), and will include wireless physiological monitoring, wireless eeg headsets (we already own the software license), and miscellaneous biophysical monitoring systems, including accelerometers and gyrometers for fall detection, gait analysis, etc.

QTY	ITEM DESCRIPTION	ESTIMATED COST	REMARKS
2	Wireless emotiv eeg headsets	\$1,000	
	Eye tracking system	\$27,000	
	Biopac system for physiological monitoring	\$8,000	
	Wireless modules for biopac (emg, eeg, skin resistivity eeg)	\$12,000	
	T1 wireless physio watch, misc. transducers	\$2,000	
2	Bioradio systems	\$10,000	
<b>TOTAL ESTIMATED COST:</b>		<b>\$60,000</b>	



# MEMS Labs

## Undergraduate Laboratory Renovation Initiative

Microelectromechanical (MEMs) Systems are embedded in every modern system, using sensors that serve many purposes in industrial, communications, biomedical, and other areas. We have a 2 course sequence in MEMs that is very project oriented and uses the equipment below extensively. A MEMs laboratory for undergraduate students in senior project lab or who are taking MEMs I and/or II is proposed. MEMs fabrication is sent off to an external site – the lab proposed here is for characterization.

**LOCATION:** ECE 006

**SQUARE FOOTAGE:** 178 ft<sup>2</sup>

**CONTACT:** Dr. Michael Giesselmann

**EMAIL:** michael.giesselmann@ttu.edu

**PHONE:** 806.742.3533

QTY	ITEM DESCRIPTION	ESTIMATED COST	REMARKS
			Class on a Chip System (\$1500/each)
MEMS I: Cost for 4 stations:		\$10,400	Computer/Monitor (\$500/each) Microscope & Stand (\$600/each)
MEMS II:			A probe station would be good for more advanced work. Minimums for a probe station would include probe manipulators (~\$3000 for 2) an Agilent (or similar) power supply (~\$2-3000) Frequency generator (\$1-2000) Microscope (~\$1500).
Other MEMS for labs: Cost for setup and accessories:		\$10,500	Freescall z-star accelerometer mote and dongle (~\$100/each) Nintendo wii-motes (accelerometer and gyroscope) (~\$40/each)

**TOTAL ESTIMATED COST: \$20,900**



# Computer Labs

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** ME 219, 224 & LC 102

**SQUARE FOOTAGE:** 2988 ft<sup>2</sup>

**CONTACT:** Dr. Randy Burkett

**EMAIL:** randy.burkett@ttu.edu

**PHONE:** 806.742.3538 x224

The **Construction Engineering Computer Lab** is used to support one senior and two junior Construction Engineering labs taken by approximately 100 students each year. The lab is used in the Cost Estimating, Project Management, and Capstone courses. During the lab portions of these classes, students are taught the fundamentals of a common construction scheduling software and a common estimating software. Construction Engineering students are then required to utilize these software packages in the completion of class projects. These courses, along with the student's exposure to the industrial software, play a critical role in the ConE undergraduate educational process.

The **Engineering Graphics Lab** is an undergraduate lab that is used to teach two freshmen undergraduate classes. Both classes teach the fundamentals of engineering graphics but utilize two different software packages. The two packages are Autodesk, a 3D Mechanical Modeling software package that is used primarily by mechanical engineering students, and AutoCAD, a 2D and 3D CAD design and documentation software that is used primarily by civil engineering and construction engineering students.

The **Mechanical Engineering Technical Laboratory** supports several courses, which require exposure to and training in the use of table-top CNC machining. In addition, the computers in the lab are used to support the teaching of a numerical methods and a computer programming course.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Mechanical Engineering Technical Laboratory LC 102 20 - Dell Computers	\$30,000	All 20 computers are 5 years old. Need to be replaced immediately.
2. Mechanical Engineering Technical Laboratory LC 102 Convert to Construction Survey Lab in 1 year	\$10,000	Reconfigure lab with tables and remove existing old equipment.
3. Engineering Graphics Laboratory ME224 44 - Dell Computers	\$60,000	All 44 computers are 3 years old. Will need replacing in 1 year.
4. Construction Engineering Computer Lab ME 219 28 - Dell Computers	\$40,000	All 28 computers just replaced. Will need replacing in 3 to 4 years.
<b>TOTAL ESTIMATED COST: \$140,000</b>		



TEXAS TECH UNIVERSITY

Department of Industrial Engineering™

# Advanced Manufacturing Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** IE 110

**SQUARE FOOTAGE:** 1888 ft<sup>2</sup>

**CONTACT:** Dr. Hong C. Zhang

**EMAIL:** Hong-Chao.Zhang@ttu.edu

**PHONE:** 806.742.3543

The Advanced Manufacturing Laboratory in the Department of Industrial Engineering is an instructional facility for undergraduate students to gain hands-on experience in the stages of product manufacturing. Starting with engineering design principles, students are exposed to Computer Aided Software (CAD-AutoDesk Inventor) for virtual geometric modeling and rapid prototyping technologies (Fused Deposition Modeling) to create physical representations of their design.

The laboratory facilities also include manual lathes and mills to expose students to the effect of manufacturing processes on product quality, as well as a Computer Numerically Controlled (CNC) machining center which provides students with practical knowledge in part programming and creates opportunities for exposure to different attained product quality characteristics.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. (100kN) Universal Test System	\$65,000	Used in manufacturing classes to teach how to determine mechanical properties of metals and polymers.
2. Differential Scanning Calorimeter	\$60,000	Used to teach how to determine thermal properties of polymers and impact of these properties in manufacturing processing
3. Thermogravimetric Analysis System	\$60,000	Used to teach how to determine degradation properties of polymers and impact of these properties in manufacturing processing.
4. Hand-held Laser Scanner (Reverse Engineering Applications)	\$60,000	Used to teach methods of data acquisition to develop reverse engineering models.
5. Arcam A1-Electron Beam System	\$1,000,000	Used to teach additive manufacturing technology for fully dense metal parts.
6. SLA/3D Printer Hybrid (ProJet 6000) - Stereolithography Apparatus (SLA)	\$150,000	Used to teach additive manufacturing technology emphasizing a new approach combining liquid- and solid-based processes.
7. 3D Printer-Objet	\$50,000	Used to teach additive manufacturing technology emphasizing solid-based technologies. Item 4 can be incorporated with teaching concepts covered by items 5-7.

**TOTAL ESTIMATED COST: \$1,445,000**



# Ergonomics Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** IE 105

**SQUARE FOOTAGE:** 500 ft<sup>2</sup>

**CONTACT:** Dr. Hong C. Zhang

**EMAIL:** Hong-Chao.Zhang@ttu.edu

**PHONE:** 806.742.3543

The Industrial Engineering Undergraduate Ergonomics Laboratory provides students an opportunity to understand and measure parameters related to the capabilities and limitations of workers.

Students explore the measurements of physiological, biomechanical, environmental, and cognitive stresses.

The laboratory gives students experience in measuring and analyzing work stresses that they will likely encounter later in their careers as industrial engineers.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Anthropometry measurement kits (5 ea @ \$2K ea)	\$10,000	Have not been upgraded in over 20 years.
2. Jackson Isometric strength testing system (2 @ \$5k ea)	\$10,000	Increased enrollments necessitate adding systems.
3. Jaymar hand grip dynamometers (5 @\$500 ea)	\$2,500	Meet increased enrollment and replacement.
4. k4b2 portable oxygen analyzer (1 @ \$40k)	\$40,000	Additional unit needed due to increased enrollment.
5. Motion Analysis digital 3 camera system (1 @ \$45k)	\$45,000	Provide additional capabilities for student projects.
6. DELSYS EMG System Myomonitor IV (2 @ \$10k ea)	\$20,000	Add new capabilities in muscle activity measurement.

**TOTAL ESTIMATED COST: \$127,500**



TEXAS TECH UNIVERSITY

Department of Mechanical Engineering™

# Mechanics and Materials Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** ME 127

**SQUARE FOOTAGE:** 1254 ft<sup>2</sup>

**CONTACT:** Dr. Jharna Chaudhuri

**EMAIL:** [jharna.chaudhuri@ttu.edu](mailto:jharna.chaudhuri@ttu.edu)

**PHONE:** 806.742.3563 x224

The Mechanics and Materials Laboratory provides undergraduate students a hands-on learning experience for information that is presented in theoretical courses.

Laboratory equipment includes Instron tensile testing machines, Impact testing machine, Rockwell hardness tester, a Metallographic specimen preparation station, an optical microscope, and heat treating ovens.

Additionally, this lab is used extensively for some projects in mechanical engineering capstone design courses, Design I and II, as well as student organizations.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Tensile Testing Machine (Frame and Control unit)	\$125,000	The existing machine is more than 20 years old and needs replacement.
2. Impact Testing Machine	\$15,000	Impact tests are designed to measure the resistance to failure of a material to a suddenly applied force. The test measures the impact energy, or the energy absorbed prior to fracture. The most common methods of measuring impact energy are the Charpy Test and the Izod Test.
3. Metallographic Specimen Preparation Station	\$25,000	Existing station is very old and outdated.
4. Four point bending testing	\$15,000	The department does not have one.
5. Torsion testing	\$15,000	The department does not have one.
6. NDE equipment (Ultrasonic)	\$25,000	The department does not have one.
7. Table top scanning electron microscope	\$60,000	The department does not have one.
8. Ovens	\$15,000	Replace existing aging ovens.

**TOTAL ESTIMATED COST: \$295,000**



TEXAS TECH UNIVERSITY

Department of Mechanical Engineering™

# Dynamic Systems & Control Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** ME 002

**SQUARE FOOTAGE:** 2494 ft<sup>2</sup>

**CONTACT:** Dr. Jharna Chaudhuri

**EMAIL:** [jharna.chaudhuri@ttu.edu](mailto:jharna.chaudhuri@ttu.edu)

**PHONE:** 806.742.3563 x224

The Dynamic Systems and Controls Laboratory teaches students practical applications of concepts from dynamics, system dynamics, vibration, and control.

Experiments teach data acquisition, signal processing, digital and analog electronics, motor control, and the power of feedback.

The available experiments are chosen to represent a variety of applications areas and physical domains and the individual final projects let the students apply the course material to problems of special interest and significance to them.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Quanser Wind Energy Testbed	\$16,396	This is a lab-scale wind turbine dynamics and control experiment. From an educational perspective it introduces issues in the dynamics and control of wind turbines, and the integration of wind energy with the grid. It would be used as a demonstration experiment and for final projects. It would also serve as a small-scale conceptual development platform for wind energy control and smart grid research projects
2. Two degrees of freedom Robot Modules - Quantity - 6 - to set up 6 experiments	\$12,402	This experiment builds upon our current one degree of freedom servo experiment to give students hands-on experience with more capable robot manipulators.
3. ROTPEN - SE- Self-Erecting - Rotary Inverted Pendulum - Quantity - 6 - to set up six experiments	\$8,700	This is a classic experiment to introduce a variety of concepts, from basic linear control to highly nonlinear state-of-the-art.
4. FLEXGAGE - Rotary Flexible Link Module (w strain/gage) - Quantity - 6 - to set up six experiments	\$12,113	Introduces students to the significant practical and conceptual challenges of controlling flexible structures, from microrobots to gantry cranes.
5. Power Supplies	\$20,000	Computer-controllable power supplies are required to power and control the experiments above (except for the wind turbine).
<b>TOTAL ESTIMATED COST:</b>		<b>\$69,611</b>



# Machine Shop Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:** ME 001

**SQUARE FOOTAGE:** 5956 ft<sup>2</sup>

**CONTACT:** Dr. Jharna Chaudhuri

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**PHONE:** 806.742.3563 x224

The Mechanical Engineering Machine Shop laboratory is used for the manufacturing and assembly of senior design students' projects, as well producing tangible parts and assemblies for professors' research in the department.

The shop has a large physical foot print with a goal of providing students and faculty with modern manufacturing equipment similar to the machines used in industry, along with the skillful knowledge required to use them in a safe and orderly fashion.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Haas VF-6, 64" X 32" X 30", 5-Axis, CNC Milling Machine	\$173,500	Indispensable for increased productivity and component size, 4X faster and more powerful than current machine.
2. Haas ST-40, 25.5" X 44", CNC Lathe	\$102,500	Indispensable for complex revolved solids.
3. Dimension 1200es Series 3D Printer	\$38,100	Rapid prototyping machine.
4. Miller Spectrum Plasma Cutter	\$2,780	Used to precisely cut large sheets of steel or aluminum up to 7/8".
5. Flow Mach 2b 1313b Waterjet	\$112,000	Fast-paced, 2D cutter for large, flat metals and plastics.
6. Faro Arm , Coordinate measuring system 3D laser scanner	\$74,019	Used to check tight tolerances on complex parts, and reverse engineering of components.
7. Accu II Milling 10" X 54" Machine	\$13,000	Replacement for our currently outdated manual milling machine.
8. Super Summit 24" X 60" Engine Lathe	\$50,789	Replacement for our currently outdated manual lathes.
9. EdgeCAM 2011 R2	\$5,500	Required for CNC programming.
10. Baileigh RDB-175 Tubing Bender w/ Round Pipe Die Package	\$10,503	Pipe and tubing bender for safety roll cages with all needed tooling.
11. Wilton/Jet 20" Geared Floor Drill Press	\$4,299	Replacement for our currently outdated floor drill press.
12. Wilton/Jet Table Top Drilling Mill	\$2,999	Replacement for cheap, broken, Fox Table Drill Press.
13. ECONOLINE Abrasive Blast Cabinet	\$5,900	60" X 48" Abrasive blasting cabinet for part surface conditioning and cleaning for weld or paint prep.
14. Bench Depot Student Project Work Benches	\$10,398	Ten 30" X 60" and three larger, metal-framed, hardwood topped student project work benches and large shop projects.
15. Hand tool sets for student use w/ tool box	\$1,643	Ten sets of hand tools, one for each project workbench.
16. Westward 4YP27 Bench Vise	\$800	Ten new 5" bench vises for the student workbenches.
17. Makita LXT218 Impact Driver/Hammer Drill Combo	\$420	Cordless power tools for shop and building maintenance needs.
18. Craftsman 204 pc. Advanced Access Professional Tool Set	\$800	Technician only shop hand tool set.
19. Wellsaw V20 Vertical Bandsaw	\$12,372	Replacement for our currently outdated aluminum band saw.
20. Makita LC1230 12" Metal Cutting Saw	\$495	Replacement for cheap, broken cut off saw.
21. ASC Econoclave Autoclave	\$225,000	4' X 8' full service autoclave for all composite materials manufacture, specifically large carbon fiber parts (FSAE, Solar-Car, etc.).
22. Accu II Milling 10" X 54" Machine	\$13,000	Replacement for our currently outdated manual milling machine.
23. Accu II Milling 10" X 54" Machine	\$13,000	Replacement for our currently outdated manual milling machine.
24. Summit 14" X 40" Engine Lathe	\$13,464	Replacement for our currently outdated manual lathes.
25. Summit 14" X 40" Engine Lathe	\$13,464	Replacement for our currently outdated manual lathes.

**TOTAL ESTIMATED COST: \$900,745**



TEXAS TECH UNIVERSITY

Department of Mechanical Engineering™

# Thermal Fluid Systems Laboratory

## Undergraduate Laboratory Renovation Initiative

**LOCATION:**

**ME 122**

**SQUARE FOOTAGE:**

**2487 ft<sup>2</sup>**

**CONTACT:**

**Dr. Jharna Chaudhuri**

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**PHONE:**

**806.742.3563 x224**

Thermal Fluids Systems Laboratory is a course that integrates the theory learned from core thermal-fluids courses with experiments providing a hands-on experience.

The fundamental energy and mass balances are exercised utilizing fundamental experiments that support theoretical knowledge.

Instruction in the lab centers on the transfer of work, energy, and material via gases and liquids.

Students learn how fluids may undergo changes in temperature, pressure, density, and chemical composition during the transfer process and may act on or be acted on by external systems.

ITEM DESCRIPTION	ESTIMATED COST	REMARKS
1. Planar PIV System with CW laser Option	\$104,127	
2. Velocity System	\$65,412	
<b>TOTAL ESTIMATED COST</b>	<b>\$169,539</b>	