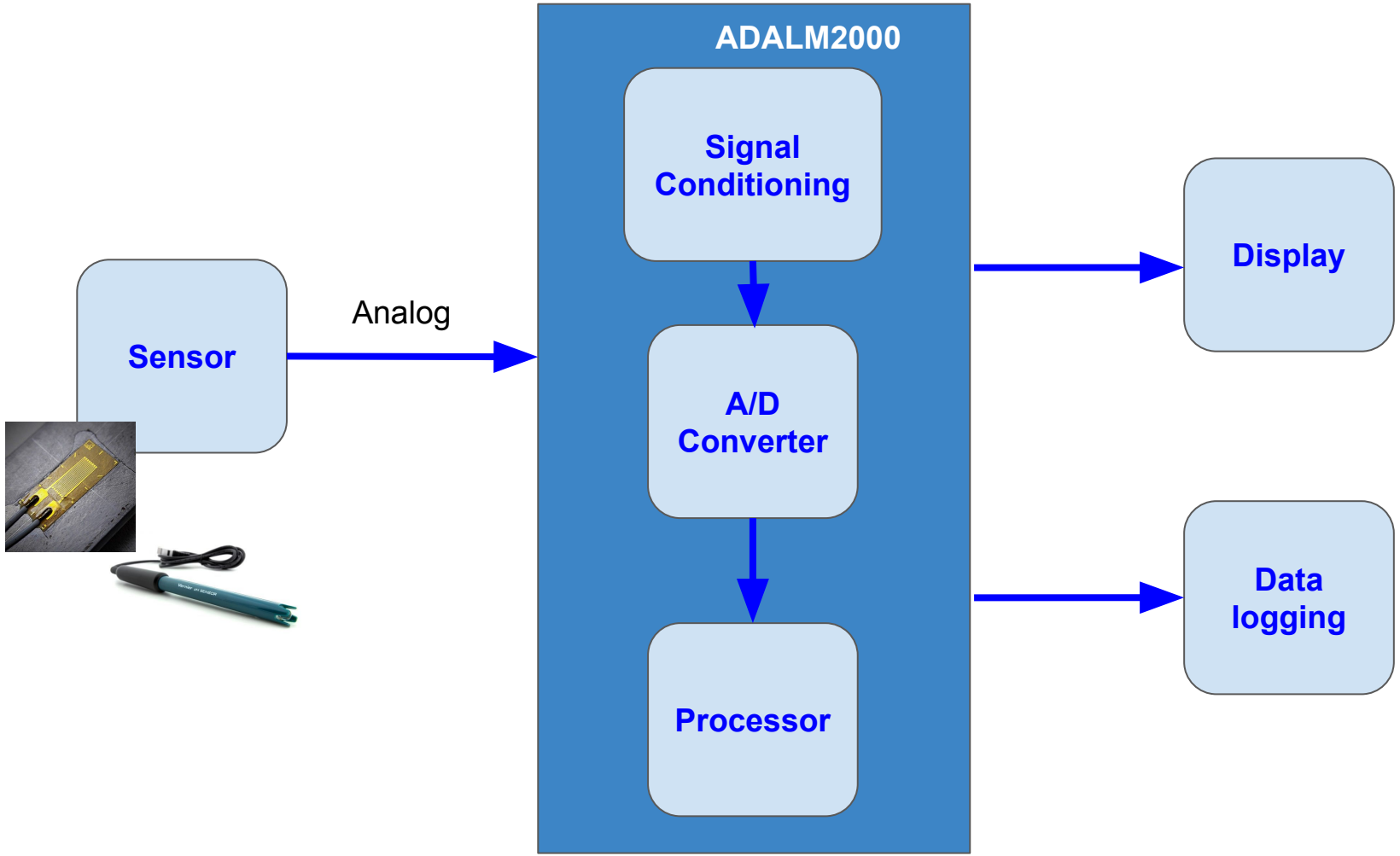
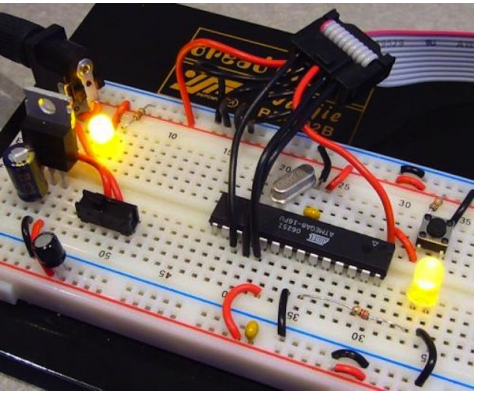
Adapting an Experiment-centric Teaching Approach to Increase Student Achievement in Multiple STEM Disciplines (ETA-STEM)

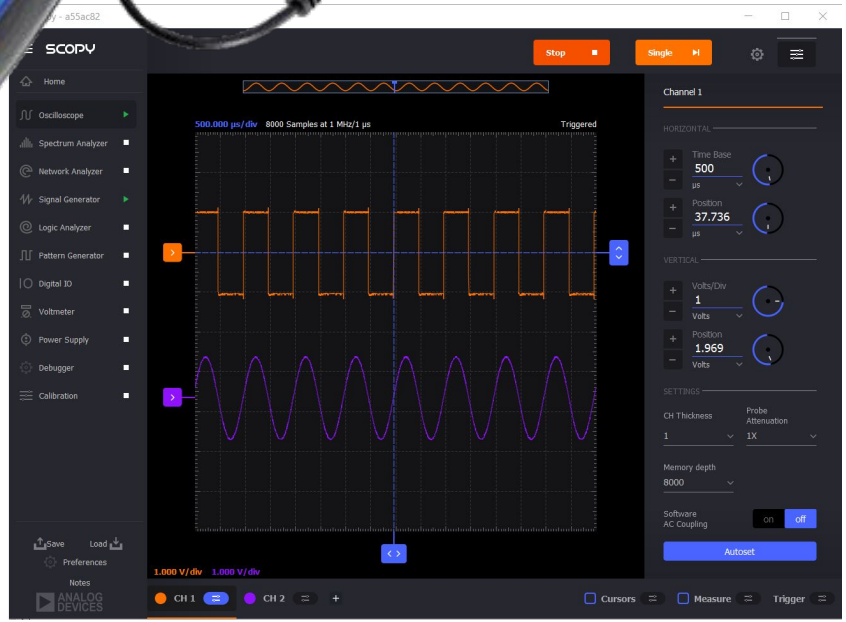
November 15, 2019

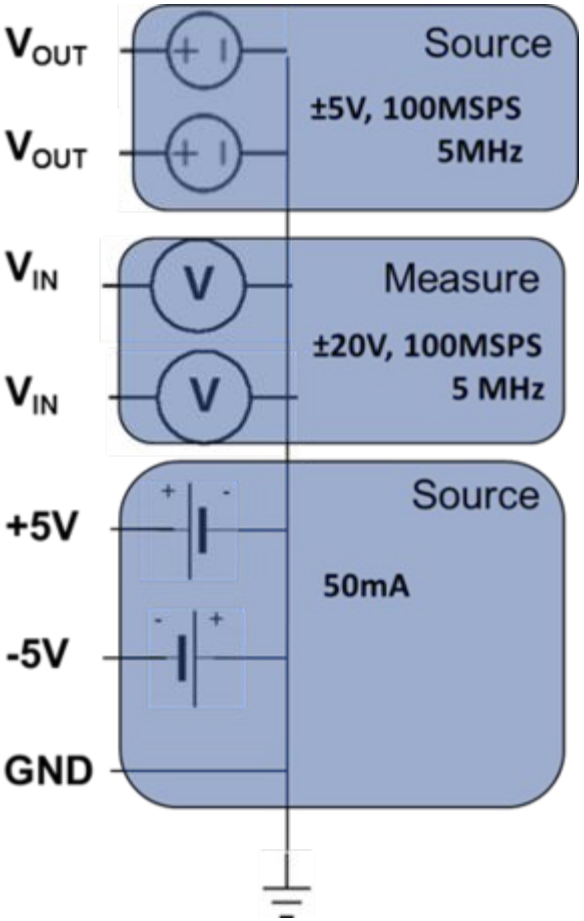

ADALM2000
Signal Conditioning
A/D Converter
Processor
Sensor
Analog
Display
Data logging

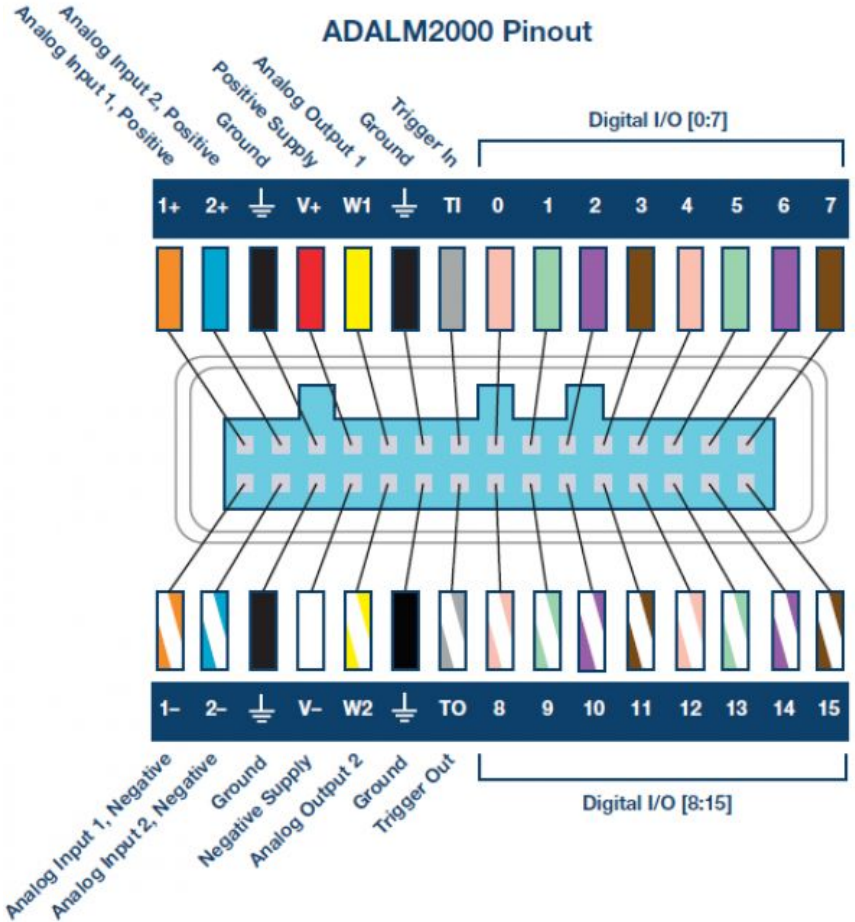
ADALM 2000

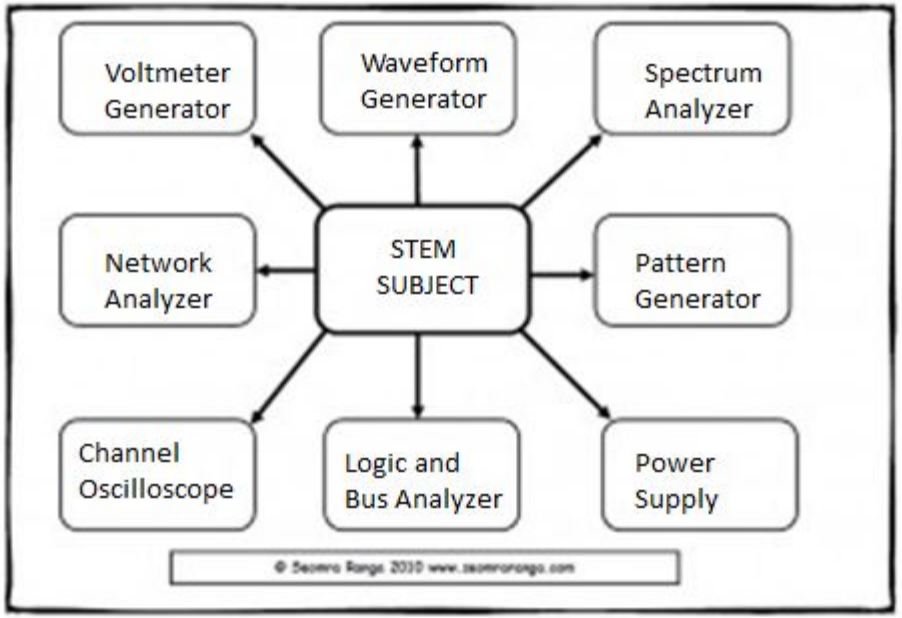


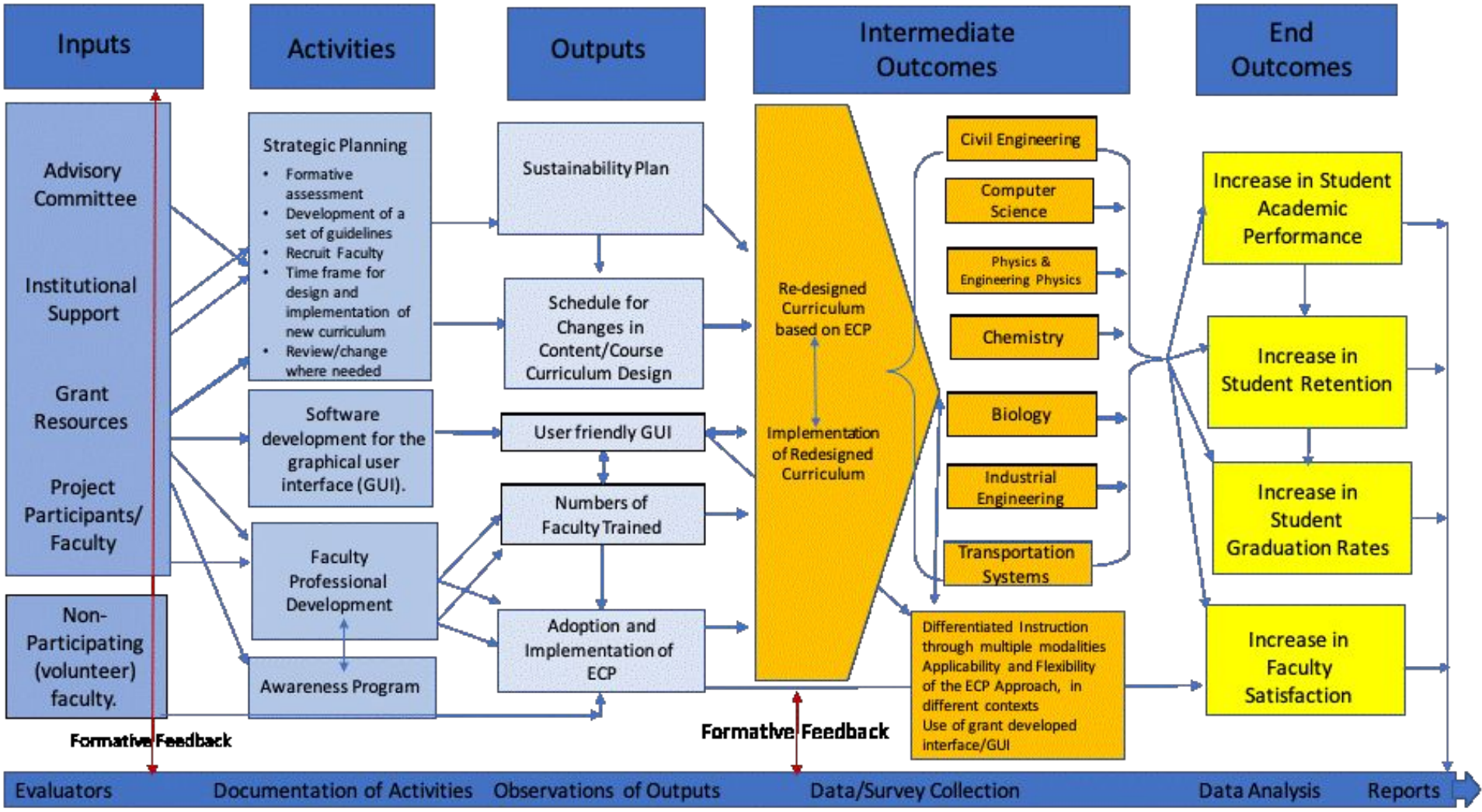

ADALM2000
Active Learning Module


SCOPY
Stop
Single
Home
Oscilloscope
Spectrum Analyzer
Network Analyzer
Signal Generator
Logic Analyzer
Pattern Generator
Digital IO
Voltmeter
Power Supply
Debugger
Calibration
500.000 µs/div
8000 Samples at 1 MHz/1 µs
Triggered
Channel 1
HORIZONTAL
Time Base
500
µs
Position
37.736
µs
VERTICAL
Volts/Div
1
Volts
Position
1.969
Volts
SETTINGS
CH Thickness
Probe Attenuation
1X
Memory depth
8000
Software AC Coupling
on
off
Autoset
Save
Load
Preferences
Notes
1.000 V/div
1.000 V/div
CH 1
CH 2
Cursors
Measure
Trigger


VOUT
VOUT
Source
±5V, 100MSPS
5MHz
VIN
VIN
Measure
±20V, 100MSPS
5 MHz
+5V
-5V
GND
Source
50mA


ADALM2000 Pinout
Analog Input 1, Positive
Analog Input 2, Positive
Ground
Positive Supply
Analog Output 1
Ground
Trigger In
Digital I/O [0:7]
1+ 2+ V+ W1 TI 0 1 2 3 4 5 6 7
1– 2– V– W2 TO 8 9 10 11 12 13 14 15
Analog Input 1, Negative
Analog Input 2, Negative
Ground
Negative Supply
Analog Output 2
Ground
Trigger Out
Digital I/O [8:15]


Voltmeter Generator
Waveform Generator
Spectrum Analyzer
Network Analyzer
STEM SUBJECT
Pattern Generator
Channel Oscilloscope
Logic and Bus Analyzer
Power Supply


Inputs
Activities
Outputs
Intermediate Outcomes
End Outcomes
Advisory Committee
Institutional Support
Grant Resources
Project Participants/ Faculty
Non-Participating (volunteer) faculty.
Strategic Planning
Formative assessment
Development of a set of guidelines
Recruit Faculty
Time frame for design and implementation of new curriculum
Review/change where needed
Software development for the graphical user interface (GUI).
Faculty Professional Development
Awareness Program
Sustainability Plan
Schedule for Changes in Content/Course Curriculum Design
User friendly GUI
Numbers of Faculty Trained
Adoption and Implementation of ECP
Re-designed Curriculum based on ECP
Implementation of Redesigned Curriculum
Civil Engineering
Computer Science
Physics & Engineering Physics
Chemistry
Biology
Industrial Engineering
Transportation Systems
Differentiated Instruction through multiple modalities
Applicability and Flexibility of the ECP Approach, in different contexts
Use of grant developed interface/GUI
Increase in Student Academic Performance
Increase in Student Retention
Increase in Student Graduation Rates
Increase in Faculty Satisfaction
Formative Feedback
Formative Feedback
Evaluators
Documentation of Activities
Observations of Outputs
Data/Survey Collection
Data Analysis
Reports

Project Details

- Project Dates: November 1 , 2019 - October 31, 2022
- Continuing grant
  - Approved on scientific / technical merit
  - Contingent on the availability of funds and the scientific progress of the project
  - Initial Award: Years 1 & 2, final year is contingent on progress

Goal /Objectives	Year 1			Year 2			Year 3		
	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer
1. To Train STEM Faculty									
1.1 To create awareness									
1.2 To offer professional development									
1.3 To document implementation of ECP									
1.4 To offer a ECP instructional program									
2. To diffuse ECP across STEM disciplines									
2. 1 To offer STEM Instructions									
2.2 Development of multidisciplinary ECP									
3. To improve students' success rate across STEM									
3.1 To increase student learning and performance									
3.2 To increase student retention									
3.3 To increase student graduation rate									
4. Creation of Institutional Advisory Board									
4.1 To monitor the ECP									
4.2 To offer professional development									
4.3 To offer a sustainable plan for the project									

High-level Research Questions

1. Does the Experimental Centric Pedagogy (ECP) enhance student learning, motivation and curiosity beyond the field of electrical engineering?

2. How do the different STEM fields integrate and customize the Experimental Centric Pedagogy to meet the learning objectives of coursework within their disciplines?

3. Does an Experimental Centric Pedagogy increase the engagement of undergraduate students in their STEM learning and lead to measurable and lasting learning gains?

4. How does the implementation of the Experimental Centric Pedagogy impact students' learning in the various STEM fields?

Courses and Concept Where ECP will Be Implemented

Disciplines (2017 Majors - BS)	**Concepts**	**Courses**
Civil Engineering (414)	Vibration of Civil Engineering Systems, Bridge Vibrations,. Bending of Cantilever, 4. Stresses and Strains	CEGR 212 Mechanics of Materials and Laboratory, 2. CEGR 324 Structural Analysis and Laboratory
Computer Science (242)	Computer Architecture, .Digital Designing, Computer Logic and Bus	COSC243 Computer Architecture COSC 247 Digital Logic
Physics and Engineering Physics (12)	Sensor Motion, Acoustic, Heat, Kinematics, Displacements	PHYS 101 Introduction to Physics, PHYS 111 Introduction to Physics (Honors), PHYS 306 Solid State and Digital Electronics, PHYS 311 Acoustic and You, PHYS 412 Laboratory Use of Microcomputers
Chemistry	Electrolysis, Forensic, Analytic Chemistry, Optics, Spectroscopy Chemical Properties and Atomic Theory.	CHEM 110/110L General Chemistry for Engineering Students,
Biology (369)	Bio cells, Oxygen Cells, Dissolved Oxygen, Water Level, Ecology, Aquatic Habitat/Ecology	BIO 101/102/103 Introductory Biology
Industrial Engineering (153)	Manufacturing Process Monitoring, Optics, Material Properties and Testing, System Quality Control, Heat Transfer and Thermal Conductivity Measurements	IEGR 309 Material Engineering, IEGR 305 Thermodynamics IEGR 363/363 L Manufacturing Process and Lab, IEGR 367 Production and Operations management
Transportation Systems (79)	Reaction Time, Crash Analysis, Speed Measurements, Simulations of Cars, Traffic Control and Devises Traffic Counts	TRSS 414 Traffic Engineering, TRSS 415 Highway Engineering, TRSS 417 Intelligent Transportation System

Spring 2020 Pilot Courses

Biology - Introductory Biology I, BIOL 101.H02
Chemistry - CHEM 203L, CHEM 204L
Civil Engineering - CEGR 324, CEGR 212, CEGR 416
Industrial Engineering - IEGR305.001, IEGR309.001
Physics - PHYS 205L.007, PHYS 206L.002

Spring 2020 - Sample labs

Biology 101	Lab 1: Scientific method - Measuring heart rate
	Lab 6: Enzymes, digestion, respiration
	Lab 7: Photosynthesis
Civil Engineering	Strain Gage
Physics	Lab 26: Equipotential and Electric Fields
	Lab 28: Resistance and Ohms Law
	Lab 33: RC time constant
	Lab 37: LRC Circuits
	Lab 38: Oscilloscope Measurements

MSU Faculty Team

Principal Investigators: Kemi Ladeji-Osias (Lead), Md M. Rahman, Uttam Gaulee, Krishna Bista, Oludare Owolabi

Participating Faculty/Senior Personnel: Mansoureh Jeihani, Steve Efe, Mehdi Shokouhian, Anthony Kinyua, Akin Oni, Adedayo Aribiyi, Niangoran Koissi, Seong Lee, Celeste Chavis

MSU Student Team

First Name	Last Name	Lead Faculty	Assigned Department
Amrita	Bhandari	Dr. Krishna Bista	ASLP
Caroline	Ndirangu	Dr. Akin Oni	Biology
Ida	Yanou Mougang	Dr. Niangoran Koissi	Chemistry
Sotonye	Ikiriko	Dr. Oludare Owolabi	Civil Engineering
Kurt	Kennedy	Dr. Antony Kinyua	Physics
Oludayo	Alamu	Dr. Seong Lee	Industrial Engineering
Ayodeji	Wemida	Dr. Kemi Ladeji-Osias	Electrical Engineering
Mojeed	Bello	Dr. Kemi Ladeji-Osias	System Design
Emmanuel	Olanrewaju	Dr. Kemi Ladeji-Osias	Design and Programming

Student Professional Development

- November/December 2019
  - Training on ADALM2000
- Winter 2020
  - Curriculum Development/Refinement
- Share progress and train new students
  - Summer 2020
  - Summer 2021
  - Summer 2022

Student Trainee Support

- Graduate Students (8)
  - One per Department (except Physics)
  - Two project-wide - EE and education
  - Payments will be processed for the end of each month - two payments in December.
  - Tuition payments will start in Spring 2020.
  - About 20 hours per week during the school year and full time in the summer. ($1,400/mo for 9 months, $2,200/mo June-Aug)

Student Trainee Support

- Undergraduate Students (2)
  - Physics Department
  - No tuition
  - $2,500/sem, $4,000 in the summer

Student Expectations

Training: 1) Completion of the CITI Responsible Conduct of Research course, 2)Participation in ETA-STEM workshops

Development: 1) Review syllabus, 2) Develop modules, 3) Redesign curriculum, 4) Identifying sensors, 5) Provide input on Graphical User Interface (GUI) for the device, 6) Refinement of the modules.

Implementation: 1) Assist in the classroom and laboratory, 2) Assisting students with ADALM2000, Collection of completed surveys and assessments, 3) Analysis and evaluation of data.

Next steps

- Fill W-9
- Demonstration by Ayodeji Wemida