



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE



SAE 2011 World Congress
Wednesday, April 13, 1-3 p.m.



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE



**William Stark, Macomb Community College
MAGMA Governing Board**

How MAGMA is Addressing Industry Needs



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

AGENDA

- MAGMA Overview, Purpose
- How MAGMA is Addressing Industry Needs
- Approved MAGMA Training Programs
 - Michigan Technological University
 - Wayne State University
 - University of Detroit Mercy
- Other Michigan Programs
- Tuition Funding Sources and How to Access
- Questions



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- In May 2008, DELEG pulled together a group from industry, education, and workforce development to validate the wide need for green mobility engineers and technicians.
- They identified a need for over 1000 engineers within the next 5 years who are trained to work in hybrid vehicle design and manufacturing. That estimate has grown substantially since then.
- Employers needed assistance in transitioning engineers and technicians from traditional automotive design and manufacturing to hybrid electric vehicle applications, advanced engine technologies, and other future green mobility technologies.
- The proposed solution was to develop an Academy to bridge the gap between technical skills/talent (on-the-job knowledge/experience) and theoretical knowledge (classroom education).
- MAGMA, leveraging the Michigan Skills Alliance model, provides a structured way for these groups to partner to address the skill gaps.



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MAGMA Mission

Provide rapid skill growth in green technology solutions for advanced mobility to meet industry needs

MAGMA Objectives

1. Prepare individuals for emerging technologies in vehicle and vehicle component design, manufacturing, and maintenance
2. Rapid/accelerated training and re-training targeted toward:
 - Incumbent and displaced engineers
 - Engineering students
 - Incumbent and displaced technicians
 - Technician program students



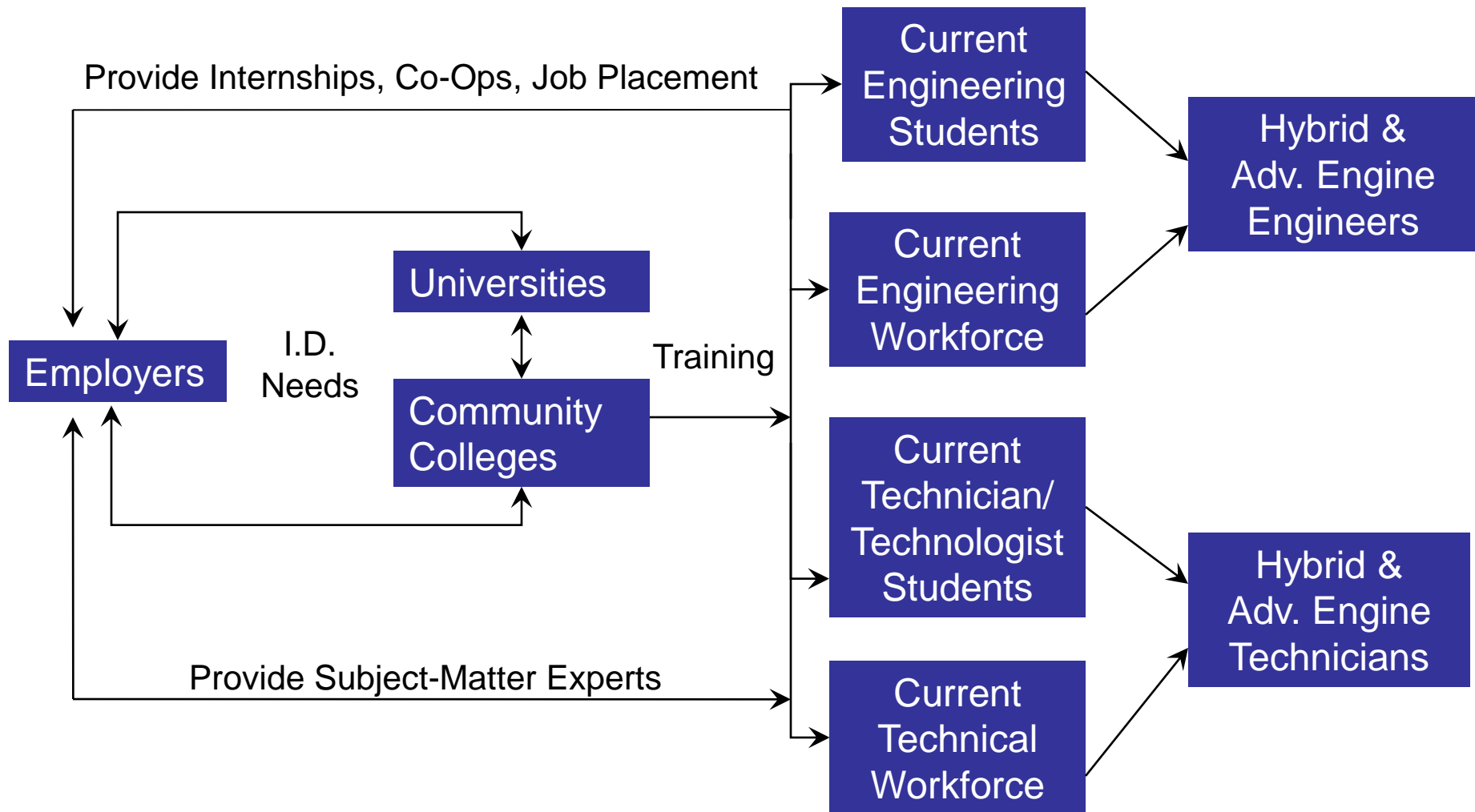
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Key Components of MAGMA

- Focus on **employer-defined** needs in green mobility
- Provide a menu of training opportunities to meet those needs
- Lead to valuable certificates and degrees
- Resulting in new and retained jobs



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Vehicle Electrification training focuses on the following key skill areas defined by employers:

- Overview of HEV, PHEV, BEV systems
- High voltage battery systems
- HEV, PHEV, BEV battery controls
- Software for HEV, PHEV, BEV control systems
- Battery and controls testing
- DC/DC converters
- Vehicle charging interface/infrastructure
- Regenerative braking
- Power electronic circuitry
- Motor control electronic hardware
- Thermal system management and control
- Systems and integration
- High voltage electric distribution systems
- Safety: working with high voltage systems

Employers emphasize “hands on” learning and labs wherever appropriate



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

Michigan Tech

Hybrid Vehicle Engineering Graduate Certificate (15 credits)

27 courses in the program

Jeffrey Naber
Carl Anderson

Google “Michigan Tech hybrid” for complete information

MICHIGAN TECH ENGINEERING

Hybrid electric vehicle engineering

Fall semester offerings
 Courses listed below in red will be available through online learning.
 EE- Electrical and Computer Engineering MEEM- Mechanical Engineering
 MEV- Vehicle Systems and Engineering CM- Chemical Engineering SM- Software
 MEEM 6200 Principles of Energy Conversion
 MEEM 6206 Intro to Propulsion Systems for HEV*
 MEEM 6208 Intro to Propulsion Systems for HEV*
 EE 4208 Intro to Propulsion Systems for HEV*
 EE 4208 Intro to Propulsion Systems for HEV*
 MEEM 5208 Advanced Thermodynamics
 MEEM 5229 Fuel Cell Technology
 MEEM 6206 Fuel Cell Technology
 MEEM 5208 Internal Combustion Engines II
 MEEM 4706 Dynamic Systems and Controls
 MEEM 5202 Experimental Design in Engineering
 MEEM 5206 Dynamic Measurement/Signal Analysis
 CM 5814 Fuel Cell Fundamentals
 CM 5700 Vehicle Battery Cells and Systems*
 MEV 5700 Vehicle Battery Cells and Systems*
 MEV 5814 Fuel Cell Fundamentals
 MEV 5800 Senior Capstone Project (Mechanical Engineering Major)
 EE 5225 Advanced Electric Machines
 EE 5120 Electric Energy Systems
 EE 5227 Power Electronics
 EE 5228 Power Electronics Lab
 EE 4221 Power System Analysis I
 EE 4201 Electrical Control Systems
 EE 494C Design Fundamentals

Spring semester offerings
 MEEM 6206 Advanced Propulsion Systems for HEV*
 MEEM 5208 Advanced Propulsion Systems for HEV*
 EE 5208 Advanced Propulsion Systems for HEV*
 EE 5221 Intro to Motor Drive
 EE 4225/5225 Power System Protection
 EE 4224/5224 Power System Protection Lab
 MEEM 4706/5706 Electrical/Electromechanical Control Systems*
 EE 4225/5225 Electrical/Electromechanical Control Systems*
 MEEM 4209 Intro to IC Engines
 EE 5222 Electric Energy Systems
 EE 4222 Power System Analysis II
 MEEM 5208 Thermodynamics/Lab Mechanics
 MEEM 4702 Dynamic Systems and Control
 MEEM 5202 Calibration/IME
 MEEM 4213 Linear Systems
 MEEM 4209 Sensor/Control Design 4021/4211**
 EE 5206 Capstone Design 5202/5211*
 MEV 5814 Hydrogen Measurements Lab*
 MEV 5810 Hydrogen Measurements Lab*
 CMF 5700/5800 Capstone

*Red listed in here above means
 **Red listed in here above means

Continuing education for professional engineers
 Michigan Techs HEV education provides advanced knowledge and hands-on labs in the design, analysis, control, optimization, and modeling of propulsion systems for HEV. This coursework has been selected by the Michigan Academy of Science Engineers for training 2200-hour engineers.

Propulsion Systems for HEVs
 This certificate, EE 4208/5208 and EE 5208, introduces students to a comprehensive study of hybrid vehicles with its continuous and robust optimization. Students investigate various and modeling techniques for power train and control system simulation. It provides hands-on performance evaluation results. Students will develop software and hardware implementations in the form of a vehicle. Advanced simulation software and design a vehicle mode for simulation. These tools are applied to design and develop the control and calibration for the hybrid powertrain to meet the HEV.

Classroom seats in Southfield, MI
 Four classes are offered in partnership with The Engineering Academy at Southfield, MI. There are also 4000 classrooms in Southfield, MI.

MEEM/EE 6206 Intro to Propulsion Systems for HEV
 CM/MEV 5700 Vehicle Battery Cells and Systems
 EE 5227 Advanced Electric Machines
 EE 4221 Power Electronics

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www.mtuonline.mtu.edu/courses

Employment or 616-487-0117
 Contact ESC at 248-363-6739
 All other please contact The Michigan Tech
 Graduate School at 734-487-3232

Michigan Tech
 Michigan Technological University

IMA
 AEL



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

MichiganTech Hybrid Vehicle Engineering Graduate Certificate

Course Information – Courses offered Distance Learning	2011 Sprg	2011 Fall	2012 Sprg	2012 Fall
Required course:				
Adv. Prop. Systems for EDV (MEEM/EE 5295) – Study of HEDVs using through powertrain component analysis and modeling. Power flows, losses and energy usage are examined for powertrain components and HEDV configurations.	DL		DL	
Any two of the Following:				
Intro. to Prop. Systems for EDV (MEEM/EE 4295) – Model based simulation and design to determine vehicle performance measures in comparison to vehicle technical specifications. Power flows, losses, energy usage, and drive quality are examined.		DL		DL
Power Electronics (EE 4227) – Fundamentals of circuits for electrical energy processing: switching converters for dc-dc, ac-dc, and dc-ac power, harmonics, pulse-width modulation, feedback control, magnetic components and power semiconductors.		DL		DL
Vehicle Battery Cells and Systems (MY/CM 5760) – Behavior and application of batteries examined through concepts of thermodynamics, materials science, transport processes and equivalent circuits		DL		DL
Advanced Electric Machines (EE 5221) – Electromechanics of rotating and linear machines, applications discussed will include renewable energy and electric propulsion systems.		DL		
Vehicle Dynamics (MEEM 5450) – Models development to predict performance & handling with comparison to selected measured data from hybrid vehicle test data.			DL	



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

MichiganTech Hybrid Vehicle Engineering Graduate Certificate

Course Information – Courses offered Distance Learning	2011 Sprg	2011 Fall	2012 Sprg	2012 Fall
Elective Courses (6 credits) *				
Distributed Embedded Control Systems (MEEM/EE 4750/5750) – Design and application of embedded control systems: system architecture, model-based system design, real-time control, communication protocols, signal processing, and human machine interface.			DL	
Power System Operations (EE 5230) – Study of advanced engineering and economic algorithms and analysis techniques for the planning, operation, and control of the electric power system from generation through transmission & distribution.		DL		DL
Distribution Engineering (EE 4225/5250) – Fundamentals of electrical distribution system design, operation, and analysis. Includes integration of distributed generation and energy storage, and recent advances in cyber and communication infrastructure.			DL	
Intro to IC Engines (MEEM 4220) – Operation and design of various types of internal combustion engines through the application of applied thermodynamics, cycle analysis, combustion, mixtures of gases, fluid dynamics, and heat transfer.	DL		DL	DL
Internal Combustion Engines II (MEEM 5250) – Advanced topics in internal combustion engines with emphasis on IC operation, modeling of engines, modeling of combustion processes, tribology, second law applications, and other topics of current interest.		DL		

* Seven additional elective courses offered via Distance Learning (DL)



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MichiganTech Lab Experiences

Laboratory Experiences

Intro. To Prop. Systems for EDV Laboratory (MEEM/EE 4296) – HEDV powertrain components examined from the aspects of safety, testing and analysis, energy conversion, losses, energy storage, and vehicle technical specifications/vehicle development process. Culminates with vehicle testing to perform power flow and energy analysis during a drive-cycle.

Adv. Prop. Systems for EDV Laboratory (MEEM/EE 5296) – HEDV components examined in a series of laboratories. Quantification of power flows and losses, calibration of component models based upon experimental data, measurement and quantification of drive quality, Failure Mode & Effects Analysis, calibration practices and trade-offs. HEDV model tuned and validated through analysis and fitting to vehicle test data.

Power Electronics Lab (EE 4228) – Design, construction and control of circuits for electrical energy processing. Covers switching converter principles for DC-DC, AC-DC, and 7 power conversion. Other topics include harmonics, pulse-width modulation, feedback control, magnetic components and power semiconductors.

Power System Protection Lab (EE 4224/5224) – Theory-based application of software and hardware used for power system protection. Fault simulations, protective relay settings and coordination, and test operation of relays under static, dynamic, and transient conditions.

Hydrogen Measurements Laboratory (CM 3978) – Introduction to experiments & measurements related to hydrogen and hydrogen-powered fuel cells. Includes chemical and electrical safety, fuel cell operation, and introduction to fuel cell integration into practical applications.

2011	2011	2011	2012	2012	2012
Sp	Su	Fall	Sp	Su	Fall
	DL	T-2cr		DL	T-2cr
T	DL		T	DL	
		T			T
T					
			T		



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

Michigan Tech

Pre-requisites and Enrollment Information

- **Standing:** BS degree in Engineering
- **Prerequisites:** Thermodynamics and Controls
- **Registration for Summer is available now.** Classes begin May 9
 - HEV Labs, Adv. Thermo, Principles of Energy Conversion, Electrical Energy Systems
- Registration for Fall 2011 Graduate students: March 17–April 3
- Registration for Fall 2011 Non-degree seeking students: March 31–April 3
- Apply [**GOOGLE: “Michigan Tech Hybrid”**
 - Questions can be directed to Marlene Lappeus \[mmlappeu@mtu.edu\]\(mailto:mmlappeu@mtu.edu\)](https://www.banweb.mtu.edu/pls/owa/bwskalog.P_Dis>LoginNon<p style=)



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE



Advanced Electric Vehicles Graduate Certificate

Dr. David S. Cameron P.E. & Dr. Shuvra Das

15 graduate credit hour program

This program has been and continues to be rapidly evolving to teach the core skills required for expertise in the design and integration of advanced electric vehicle design and manufacturing. This program developed rapidly in partnership with Ford Motor Company. Ford provided access to subject-matter experts to provide a teaching balance of applied methodology and state-of-the-art research. As these courses are taught at the graduate level, many can be applied toward engineering master's degree programs

After the first year, 28 students completed the AEV Certificate program



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE



Advanced Electric Vehicles Graduate Certificate

This is set up as a 5-course certificate program (15 graduate credit hours). Three courses are mandatory (AEV 5010, 5020, 5050), with 2 more electives from the 4 elective courses offered (AEV 5030, 5040, 5060, 5070).

The purpose of this program is to quickly infuse the engineer with a working knowledge of these technical topics within the emerging Electric Vehicle engineering field.



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Advanced Electric Vehicles Graduate Certificate

AEV5010 Introduction to Advanced Electric Vehicles (required)

Fundamentals of AEVs and key challenges and opportunities of AEV technologies. The course will explain the engineering philosophy of various AEVs (HEV, PHEV and BEV) and, the component selection and design, modeling, and control of AEVs. Some existing AEV models will be used as case studies.

AEV5020 Controls Modeling and Design for AEV (required)

System and sub-systems, modeling and design of AEVs as a system, principles of controls engineering for AEV. Significant use of software tools.



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Advanced Electric Vehicles Graduate Certificate

AEV5030 Energy Storage Systems

Energy storage systems used in electric vehicles, batteries. Battery electro-chemistry, battery design and construction, charging and discharging, power density, interaction of the batteries with other sub-systems.

AEV5040 Power Electronics for Electric Vehicles

Power electronics including switching, AC-DC, AC-AC conversion, electronic devices and circuits used for control and distribution of electric power.

AEV5050 Electric Drives/Electromechanical Energy Conversion (req.)

Variety of linear and rotary actuators, their characteristics, operating range and interactivity within power train system.



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Advanced Electric Vehicles Graduate Certificate

AEV5060 Innovation and System Architecture Engineering

A variety of innovation techniques will be demonstrated and a methodical, proven approach to architecture will be studied. Theory and a variety of case studies – some related to Advanced Electric Vehicles (AEV) – will be used to illustrate successful, and not so successful, practices.

AEV5070 Systems Engineering for AEV

Technologies which disrupt the way things have historically been done, such as a transition to Advanced Electric Vehicles (AEVs), coupled with increasing use of digital tools in the design and validation processes warrant taking a very close look at the best tools and practices for executing the systems engineering process. Advanced Electric Vehicle (AEV) concepts will be used for careful decomposition and evaluation.



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Advanced Electric Vehicles Graduate Certificate

The pre-requisite for admission into this program is a Bachelor of Science in engineering. Other criteria may be applied, depending on which engineering degree was earned.

The application is online at:

http://prodapp1.udmercy.edu:9010/pls/198.109.28.152_PROD/bwskalog.P_DisLoginNon

For questions or assistance, please call the program office at 313-993-1128
David Cameron
Val Glisson



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

Graduate Certificate Program in Electric Drive Vehicle Engineering

K. Y. Simon Ng
Director, EVE Program
Interim Associate Dean for Research
Wayne State University

Contact Information

Ms. Andrea Eisenberg, 313-577-3716
aeisen@eng.wayne.edu

Website: <http://www.eng.wayne.edu/eve>



Electrifying the Economy
Educating the Workforce



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

MAGMA WSU EVE Graduate Certificate

Program Requirement

- 15 credit hours
- 4 Courses (2 required and 2 elective)
- Up to 3 credits can be transferred from other MAGMA approved courses
- Up to 9 credits can be applied towards a WSU M.S. degree





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Required Courses (8 Credits)

- **EVE 5110** Fundamentals of Electric-drive Vehicle Engineering (4 credits)
General backgrounds of electric and hybrid electric vehicle (HEV) related technologies, including technical concepts, design factors, energy analysis, and unified modeling approach.
- **EVE 5120** Fundamentals of Battery Systems for Electric and Hybrid Vehicles (4 credits)
This course addresses the fundamental electro-chemistry and design aspects for secondary batteries for electric propulsion applications at battery cell, module, and system levels.





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- Elective Courses (8 Credits)**
- **EVE 5310 Electric-drive Vehicle Modeling and Simulation (4 credits)**
Fundamentals in modeling of energy conversion, storage, utilization and optimization of complete ground vehicle systems for conventional, electric and hybrid vehicles.
 - **EVE 5410 Power Electronics and Control (4 credits)**
Control of electric energy using solid-state devices, diodes, thyristors, triacs; mathematical analysis of circuits containing these devices; power converters and control; solid-state drives for motor control.





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Elective Courses (continued)

- **EVE 5430** Modeling and Control of Electric-drive Powertrains (4 credits)

Understand how power electronic circuits and motors are combined with battery systems, internal combustion engines to form an EDV (electric drive vehicle) power train. The course will cover dynamic modeling and control of power electronics, motors, battery systems, and power regeneration.

- **EVE 5600** Electric-drive Vehicle Product and Infrastructure Development (4 credits)

This course will provide students the design and development experience of electric vehicle products. It will demonstrate process framework related to electric vehicle product design and concept validation methodology.





MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

Graduate Certificate Program in Electric Drive Vehicle Engineering

Contact Information

Ms. Andrea Eisenberg, 313-577-3716

aeisen@eng.wayne.edu

Website: <http://www.eng.wayne.edu/eve>





MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

- Michigan Schools with DOE EV Curriculum
 - Kettering University
 - University of Michigan
 - Michigan Technological University
 - Wayne State University- Engineering
 - Wayne State University- Engrg Technology
 - Macomb Community College



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

MAGMA Accomplishments

- More than 320 students enrolled in WSU, MTU, UDMercy programs since 2009
- Over \$3 million dollars of state and federal funding leveraged to help underwrite cost of training



MICHIGAN ACADEMY FOR GREEN MOBILITY ALLIANCE

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Michigan Academy for Green Mobility Alliance (MAGMA)

An Alliance to Skill Workers for Green Mobility Jobs
 In response to the rapid growth in the renewable energy sector, the Michigan Department of Energy, Labor & Economic Growth collaborated with automotive manufacturing employers and educational institutions to establish the Michigan Academy for Green Mobility Alliance (MAGMA) in conjunction with the Governor's No Worker Left Behind Green Jobs Initiative.

Automotive manufacturers and their suppliers project a need for over 1,000 additional engineers and technicians over the next five years that are trained to work in hybrid vehicle design and manufacturing.

The purpose of MAGMA is to ensure the automotive industry has the trained workers they need to grow and prosper in the emerging green economy. The skill development and training provided through the Academy is in direct response to specific knowledge and skill demands of employers in the automotive manufacturing industry.

In response to industry's requirements, education and training institutions support MAGMA by developing learning opportunities that are targeted, innovative, flexible, and have a strong focus on hands-on practical experience.

Academy Mission:
 Provide rapid skill growth in green technology solutions for advanced mobility to meet industry needs.

Academy Objectives:

- Prepare individuals for emerging technologies in vehicle propulsion and vehicle component design, manufacturing, and maintenance through rapid/accelerated training and re-training.
- Target the training to displaced and incumbent engineers, engineering students, displaced and incumbent technicians, and technician program students.
- When possible, seek and provide funding to help employers or individuals access the training.

REGISTER FOR A FREE INFORMATIONAL WEBINAR, February 23, 11:00 A.M. TO 12:15 P.M. EST, TO LEARN MORE ABOUT MAGMA, TRAINING FUNDS, AND APPROVED TRAINING PROGRAMS!

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