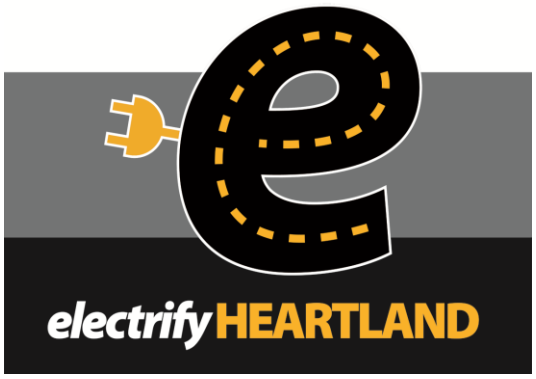
Electrify Heartland Plan

Appendix G: Automotive Technician Curriculum



Project title: Kansas – Missouri
Community Readiness for EV and EVSE

Funded by: US DOE DE-EE0005551

By: Metropolitan Energy Center

and Kansas City Regional Clean Cities Coalition

With: Black & Veatch

Metropolitan ENERGY CENTER

Kansas City Regional Clean Cities

BLACK & VEATCH

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U.S. Department of Energy Acknowledgement and Disclaimer:

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This work was developed in response to the federal funding opportunity announcement titled Clean Cities Community Readiness and Planning for Plug-in Electric Vehicles and Charging Infrastructure. FOA: DE-FOA-0000451

CFDA Number 81.086

Electrify Heartland Plan

Electrify Heartland Project Abstract

Electrify Heartland is an electric vehicle planning project managed by Metropolitan Energy Center. It is a product of the Greater Kansas City Plug-In Readiness Initiative, co-chaired by Kansas City Regional Clean Cities Coalition. Our goal is to produce a regional plan to prepare public resources and secure the economic and environmental benefits of plug-in vehicles within targeted metro areas with estimated 2.7M population. The targeted metro areas include Kansas City, MO & KS; Jefferson City, MO, Wichita, KS; Salina, KS; Lawrence, KS; and Topeka, KS. (14 Counties: Cass, Clay, Cole, Douglas, Jackson, Johnson, Leavenworth, Miami, Platte, Ray, Saline, Sedgwick, Shawnee, Wyandotte).

Electrify Heartland Steering Committee

Team	Organization	Name
Charging Stations	Initiatives	Troy Carlson
Charging Stations	LilyPadEV	Larry Kinder
Charging Stations	Logios	Gustavo Collantes
Government Policy	Polsinelli Shughart PC	Alan Anderson
Government Policy	Black & Veatch	Bill Roush
Project Administration	Metropolitan Energy Center	Ruth Redenbaugh
Project Administration	Metropolitan Energy Center	Kelly Gilbert
Public Education	Nation Ranch Marketing, Inc.	Bill Patterson
Training	Kansas City Kansas Community College	Bob McGowan
Training	National Electrical Contractors Association	Jim Cianciolo
Utility Grid	Black & Veatch	Sam Scupham
Vehicle & Fleet	University of Missouri at Kansas City	Henry Marsh

Exhibit i-i. Electrify Heartland Steering Committee Members

Table of Appendices

The following appendices are in separate files on www.ElectrifyHeartland.org

A. EV Readiness Index

B. Greater Kansas City Plug-in Readiness Strategy

C. Grant Proposal for Project

D. EVSE Permitting Recommendations

E. Federal Highway Administration Signage Memorandum

F. EV Business Coalition

G. Automotive Technician Curriculum

H. Electric Vehicle Infrastructure Training Program promotion

I. Getting started with EV

J. Electric Vehicle Fleet Tools

K. Electric Vehicle Hangtag

L. EVSE Site Host Considerations

M. Initial Website Map

N. Air Quality

O. EV Ready Communities

P. Sample Presentations about EV Forecasts and Redirected Spending Potential

Q. EVSE Corridor Analysis

R. Blank

S. Blank

T. Blank

U. Social Media

V. Press Kit

W. Contributors

X. Exhibits

Y. Glossary

Z. Bibliography

Appendix G: Automotive Technician Curriculum

Synopsis

This appendix to the Electrify Heartland Plan is a curriculum for a hybrid electric vehicle training program that was developed for a community college associate degree certificate.

Section Authors:

Bob McGowan, Kansas City Kansas Community College

1.1 Course Numbers and Titles

AHEV 102	**Course Title: Hybrid Electric Vehicle Safety for First Responders and Dismantlers**
AHEV 203	**Course Title: Basic Hybrid Electric Vehicles**
AHEV 212	**Course Title: Hybrid Electric Vehicle Internal Combustion Engines and Alternate Power**
AHEV 222	**Course Title: Hybrid Electric Vehicle Transmissions**
AHEV 262	**Course Title: Hybrid Electric Vehicle Batteries**
AHEV 265	**Course Title: Hybrid Electric Vehicle Accessories**
AHEV 282	**Course Title: Hybrid /Electric Vehicles Inverters, Converters and Electric Motors**

The curriculum outlines for each course follow.

Next steps are to develop component modules for professionals and the public who want specific training in a particular topic from the advanced to the basic level.

SYLLABUS

DATE OF LAST REVIEW : Spring 2010

CIP CODE: **47.0614**

SEMESTER: Departmental Syllabus

COURSE TITLE: Hybrid Electric Vehicle Safety for First Responders and Dismantlers

COURSE NUMBER: **AHEV 102**

CREDIT HOURS: 1

INSTRUCTOR: Departmental Syllabus

OFFICE LOCATION: Departmental Syllabus

OFFICE HOURS: Departmental Syllabus

TELEPHONE: Departmental Syllabus

EMAIL : Departmental Syllabus

PREREQUISITE(S): None

REQUIRED TEXT AND MATERIALS:
Please see bookstore for current textbook(s) and other required material.

COURSE DESCRIPTION:
The student will learn to safely deal with the hybrid electric vehicle in the event of accidents, disassembly and disposal. The course will emphasize the importance of safety due to the deadly nature of the high voltage environment. Students are required to supply their own high voltage class 0 gloves to participate in live lab experiences.

METHOD OF INSTRUCTION:
A variety of instructional methods may be used depending on content area. These include but are not limited to: lecture, multimedia, cooperative/collaborative learning, labs and demonstrations, projects and presentations, speeches, debates, and panels, conferencing, performances, and learning experiences outside the classroom. Methodology will be selected to best meet student needs.

COURSE OUTLINE:
All students must comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the

handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

I. Introduction to Hybrid and Electric Vehicles
    A. Identifying a hybrid
    B. Identifying hybrid components
    C. HEV technologies
II. High voltage electrical safety
    A. Electric shock
    B. Personal Protection Equipment PPE
    C. Electrical isolation
III. High Voltage Vehicle Safety Systems
    A. Hybrid high voltage safety systems
    B. Service disconnect switch systems
    C. Battery safety
    D. Module safety
    E. High voltage cables
    F. Myths
IV. Emergency Procedures
    A. Approaching a damaged vehicle
    B. Fire
    C. Submerged
    D. Extrication
    E. Crushed battery
V. Servicing Damaged HEV's
    A. Towing
    B. Dismantling HV components
    C. Battery box removal
    D. Damaged battery service
    E. Disposal
VI. Vehicle specific information
    A. Manufacturers procedures for common HEV's
    B. Manufacturers websites
    C. Keeping up to date

EXPECTED LEARNER OUTCOMES:

A. The student will be able to identify HEV's basic components
B. The student will be able to describe high voltage electrical safety
C. The student will be able to explain high voltage vehicle safety systems
D. The student will be able to explain emergency procedures
E. The student will be able to explain how to servicing damaged HEV's
F. The student will be able to demonstrate where to locate vehicle specific information

COURSE COMPETENCIES:

The student will be able to identify HEV's basic components

1. Identify hybrid electric vehicles from non-hybrid vehicles
2. Identify basic components on a HEV and EV

The student will be able to describe high voltage electrical safety

3. Explain dangers of high voltage
4. Describe the use of personal protection equipment for electrical safety

The student will be able to explain high voltage vehicle safety systems

5. Explain the safety systems in a HEV
6. Demonstrate proper operation of a service disconnect procedure
7. Explain high voltage insulation identification

The student will be able to explain emergency procedures

8. Explain procedure for approaching a damaged HEV
9. Explain additional concerns for fire in an HEV
10. Explain additional concerns for extrication in HEV
11. Explain additional concerns for a submerged HEV

The student will be able to explain how to servicing damaged HEV's

12. Describe how to safely tow a HEV
13. Explain how to dismantling HV components
14. Explain how to remove a HV battery box
15. Describe what to do with a damaged battery
16. Explain proper instruction for disposal of components

The student will be able to demonstrate where to locate vehicle specific information

17. Demonstrate where to find updated vehicle specific information

ASSESSMENT OF LEARNER OUTCOMES:

Assessment methods may include, but are not limited to, the following: Homework, Assignments, Quizzes, Class Participation, Chapter Tests, and Final Exam. The grading scale and the process for calculating the course grades are to be determined by the individual instructors. This information will be included in each instructor's syllabus.

SPECIAL NOTES:

This syllabus is subject to change at the discretion of the instructor. Material included is intended to provide an outline of the course and rules that the instructor will adhere to in evaluating the student's progress. However, this syllabus is not intended to be a legal contract. Questions regarding the syllabus are welcome any time.

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Kansas City Kansas Community College complies with the Americans with Disabilities Act. If you need accommodations due to a documented disability, please contact Valerie Webb, in Rm. 3354 or call at: 288-7670 V/TDD.

KANSAS CITY KANSAS COMMUNITY COLLEGE

COMPETENCY INDEX

Course Number/Section/Title: AHEV 102 Hybrid Safety for First Responders and Dismantlers

Student Name: _____ Student Number:_____

Instructor: _____ Division: _____

RATING SCALE for Competency Achievement

4 Superior
3 Good
2 Average
1 Inferior
0 Failure
NA Not Addressed

DIRECTIONS:

Evaluate the student by checking or highlighting the appropriate number to indicate the degree of competency achieved.

Hybrid Safety for First Responders and Dismantlers

For every task in Hybrid Safety for First Responders and Dismantlers, the following safety requirement must be strictly enforced:

Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

4 3 2 1 0 NA	1. Identify hybrid electric vehicles from non-hybrid vehicles
4 3 2 1 0 NA	2. Identify basic components on a HEV and EV
4 3 2 1 0 NA	3. Explain dangers of high voltage
4 3 2 1 0 NA	4. Describe the use of personal protection equipment for electrical safety
4 3 2 1 0 NA	5. Explain the safety systems in a HEV
4 3 2 1 0 NA	6. Demonstrate proper operation of a service disconnect procedure
4 3 2 1 0 NA	7. Explain high voltage insulation identification
4 3 2 1 0 NA	8. Explain procedure for approaching a damaged HEV
4 3 2 1 0 NA	9. Explain additional concerns for fire in an HEV
4 3 2 1 0 NA	10. Explain additional concerns for extrication in HEV

4 3 2 1 0 NA	11. Explain additional concerns for a submerged HEV
4 3 2 1 0 NA	12. Describe how to safely tow a HEV
4 3 2 1 0 NA	13. Explain how to dismantling HV components
4 3 2 1 0 NA	14. Explain how to remove a HV battery box
4 3 2 1 0 NA	15. Describe what to do with a damaged battery
4 3 2 1 0 NA	16. Explain proper instruction for disposal of components
4 3 2 1 0 NA	17. Demonstrate where to find updated vehicle specific information

Please check one of the following:

_____I certify that the student completed the course and the competencies indicated as indicated.

_____I certify that the student completed 25% of the course competencies, as indicated.

Instructor Signature:

Date:

SYLLABUS

DATE OF LAST REVIEW : Spring 2010

CIP CODE: **47.0614**

SEMESTER: Departmental Syllabus

COURSE TITLE: Basic Hybrid Electric Vehicles

COURSE NUMBER: **AHEV 203**

CREDIT HOURS: 3

INSTRUCTOR: Departmental Syllabus

OFFICE LOCATION: Departmental Syllabus

OFFICE HOURS: Departmental Syllabus

TELEPHONE: Departmental Syllabus

EMAIL : Departmental Syllabus

PREREQUISITE(S): AUTT 262, AUTT 182 or approval by the instructor.

REQUIRED TEXT AND MATERIALS:
Please see bookstore for current textbook(s) and other required material.

COURSE DESCRIPTION:
The student will learn basic theory and operation of hybrid drive systems in the automobile. The content will cover basic theory of batteries, charging, transmission, inverter/converter operation, cooling systems, diagnosis and repair of these advanced and unique automobiles. The course will strongly emphasize the importance of safety due to the deadly nature of the high voltage environment. Students are required to purchase their own high voltage class 0 gloves to participate in live lab experiences.

METHOD OF INSTRUCTION:
A variety of instructional methods may be used depending on content area. These include but are not limited to: lecture, multimedia, cooperative/collaborative learning, labs and demonstrations, projects and presentations, speeches, debates, and panels, conferencing, performances, and learning experiences outside the classroom. Methodology will be selected to best meet student needs.

COURSE OUTLINE:
All students must comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

I. Introduction to Hybrid and Electric Vehicles
    A. Series design
    B. Parallel design
    C. HEV technologies
II. High Voltage Electrical Safety
    A. Electric shock
    B. Tool and equipment usage and high voltage systems
    C. Electrical isolation
    D. Multimeters
    E. CAT III
III. High Voltage Vehicle Safety Systems
    A. Hybrid high voltage safety systems
    B. Serial interlock loop
    C. Service disconnect switch systems
    D. Testing for isolation faults
IV. AC Motor Operation
    A. Electric motor theory
    B. Electric vehicle system components
    C. The rotor and stator
V. Power Inverter and Converter Systems
    A. Power inverter operation
    B. The hybrid and electric power systems
    C. Basic motor controls
    D. Regenerative braking
    E. DC-DC converters
    F. Power generation
VI. Basic Electric Motor Sensing Systems
    A. Motor speed sensing
    B. Resolver
    C. Motor load / current sensing
    D. Throttle / brake pedal position sensing
VII. Transmission/Transaxles and Cooling Systems
    A. Electric& planetary gear operation
    B. Gear ratio blending between EM and ICE
    C. Cooling systems
VIII. Energy Management Operation
    A. High voltage fuse
    B. Current sensing
    C. Battery contactors
    D. Battery cooling and temperature sensing

E. Battery pack controller

IX. Nickel Metal Hydride Batteries
- A. Charge and discharge electrical characteristics
- B. NiMH capacity
- C. Advantages
- D. Disadvantages

X. Other Systems
- A. Hybrid jump starting
- B. Electro-hydraulic power steering system
- C. Vehicle braking system
- D. Driver information center
- E. Electric compressors

EXPECTED LEARNER OUTCOMES:

- A. The student will be able to describe hybrid and electric vehicle operation
- B. The student will be able to describe in detail high voltage electrical safety
- C. The student will be able to explain high voltage vehicle safety systems
- D. The student will be able to summarize A/C electric motor operation
- E. The student will be able to describe power inverter and converter operation
- F. The student will be able to explain basic electric propulsion sensing systems
- G. The student will be able to review transaxles, gears
- H. The student will be able to explain energy management operation
- I. The student will be able to summarize nickel metal hydride technology
- J. The student will be able to review other systems

COURSE COMPETENCIES:

The student will be able to describe hybrid and electric vehicle operation

1. Explain series, parallel and series parallel hybrid drives
2. Explain power flow through parallel, series and series parallel drives

The student will be able to describe in detail high voltage electrical safety

3. Define high voltage and explain the implications of human interaction
4. Explain the purpose of personal protection equipment and what they do
5. Demonstrate how to wear high voltage personal protection equipment
6. Explain when and where personal protection equipment will be worn

The student will be able to explain high voltage vehicle safety systems

7. Demonstrate how to disable high voltage safety systems on hybrid vehicles
8. Demonstrate location of isolation faults in high voltage circuits

The student will be able to summarize A/C motor operation

9. Explain how an electric motor works
10. Explain how a brushless motor works
11. Explain rotor and stator interaction

The student will be able to describe power inverter and converter operation

12. Review the operation of the power inverter
13. Explain DC/DC converter operation
14. Describe regenerative braking

The student will be able to explain basic electric propulsion sensing systems

15. Describe motor speed sensing
16. Explain how motor load and electrical current sensing takes place
17. Describe throttle //pedal position sensing

The student will be able to review transaxles, gears, and cooling systems

18. Explain planetary gear sets and their relationships
19. Explain gear ratio blending between the drive motors and the ICE
20. Describe cooling systems for the power inverter and how to service them

The student will be able to explain energy management operation

21. Explain the basic operation of battery contactors
22. Describe basic operation of the HV battery cooling system for different models
23. Explain the basic operation of the HV battery controller
24. Describe what happens in a low charge condition to the HV battery

The student will be able to summarize nickel metal hydride technology

25. Describe the advantages and disadvantages of the NiMH battery
26. Describe the chemical changes that occur during charging and discharging

The student will be able to review other systems

27. Describe how brakes differ from non hybrid vehicles to hybrid vehicles
28. Explain battery service mode
29. Describe how electric compressors work
30. Explain vehicle jump starting

ASSESSMENT OF LEARNER OUTCOMES:
Assessment methods may include, but are not limited to, the following: Homework, Assignments, Quizzes, Class Participation, Chapter Tests, and Final Exam. The grading scale and the process for calculating the course grades are to be determined by the individual instructors. This information will be included in each instructor's syllabus.

SPECIAL NOTES:
This syllabus is subject to change at the discretion of the instructor. Material included is intended to provide an outline of the course and rules that the instructor will adhere to in evaluating the student's progress. However, this syllabus is not intended to be a legal contract. Questions regarding the syllabus are welcome any time.

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KANSAS CITY KANSAS COMMUNITY COLLEGE

COMPETENCY INDEX

Course Number/Section/Title: _AHEV 203 Basic Hybrid Electric Vehicles _____

Student Name: _____ Student Number:_____

Instructor: _____ Division: _____

RATING SCALE for Competency Achievement

4 Superior
3 Good
2 Average
1 Inferior
0 Failure
NA Not Addressed

DIRECTIONS:

Evaluate the student by checking or highlighting the appropriate number to indicate the degree of competency achieved.

Basic Hybrid Electric Vehicles

For every task in Basic Hybrid Electric Vehicles, the following safety requirement must be strictly enforced:

Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

4 3 2 1 0 NA	1. Explain series, parallel and series parallel hybrid drives
4 3 2 1 0 NA	2. Explain power flow through parallel, series and series parallel drives
4 3 2 1 0 NA	3. Define high voltage and explain the implications of human interaction
4 3 2 1 0 NA	4. Explain the purpose of personal protection equipment and what they do
4 3 2 1 0 NA	5. Demonstrate how to wear high voltage personal protection equipment
4 3 2 1 0 NA	6. Explain when and where personal protection equipment will be worn
4 3 2 1 0 NA	7. Demonstrate how to disable high voltage safety systems on hybrid

	vehicles
4 3 2 1 0 NA	8. Demonstrate location of isolation faults in high voltage circuits
4 3 2 1 0 NA	9. Explain how an electric motor works
4 3 2 1 0 NA	10. Explain how a brushless motor works
4 3 2 1 0 NA	11. Explain rotor and stator interaction
4 3 2 1 0 NA	12. Review the operation of the power inverter
4 3 2 1 0 NA	13. Explain DC/DC converter operation
4 3 2 1 0 NA	14. Describe regenerative braking
4 3 2 1 0 NA	15. Describe motor speed sensing
4 3 2 1 0 NA	16. Explain how motor load and electrical current sensing takes place
4 3 2 1 0 NA	17. Describe throttle //pedal position sensing
4 3 2 1 0 NA	18. Explain planetary gear sets and their relationships
4 3 2 1 0 NA	19. Explain gear ratio blending between the drive motors and the ICE
4 3 2 1 0 NA	20. Describe cooling systems for the power inverter and how to service them
4 3 2 1 0 NA	21. Explain the basic operation of battery contactors
4 3 2 1 0 NA	22. Describe basic operation of the HV battery cooling system for different models
4 3 2 1 0 NA	23. Explain the basic operation of the HV battery controller
4 3 2 1 0 NA	24. Describe what happens in a low charge condition to the HV battery
4 3 2 1 0 NA	25. Describe the advantages and disadvantages of the NiMH battery
4 3 2 1 0 NA	26. Describe the chemical changes that occur during charging and discharging
4 3 2 1 0 NA	27. Describe how brakes differ from non hybrid vehicles to hybrid vehicles
4 3 2 1 0 NA	28. Explain battery service mode
4 3 2 1 0 NA	29. Describe how electric compressors work
4 3 2 1 0 NA	30. Explain vehicle jump starting

Please check one of the following:

_____I certify that the student completed the course and the competencies indicated as indicated.

_____I certify that the student completed 25% of the course competencies, as indicated.

Instructor Signature:

Date:

SYLLABUS

DATE OF LAST REVIEW : Spring 2010

CIP CODE: **47.0614**

SEMESTER: Departmental Syllabus

COURSE TITLE: Hybrid Electric Vehicle Internal Combustion Engines and Alternate Power

COURSE NUMBER: **AHEV 212**

CREDIT HOURS: 3

INSTRUCTOR: Departmental Syllabus

OFFICE LOCATION: Departmental Syllabus

OFFICE HOURS: Departmental Syllabus

TELEPHONE: Departmental Syllabus

EMAIL : Departmental Syllabus

PREREQUISITE(S): AUTT 162, AUTT 181
or approval by the instructor.

REQUIRED TEXT AND MATERIALS:
Please see bookstore for current textbook(s) and other required material.

COURSE DESCRIPTION:
The student will learn the theory and operation of the internal combustion engine as it relates to hybrid systems. Studies will also include alternate power systems including diesel, CNG, and fuel cell technology. The course will emphasize the importance of safety due to the deadly nature of the high voltage environment. Students are required to purchase their own high voltage class 0 gloves to participate in live lab experiences.

METHOD OF INSTRUCTION:
A variety of instructional methods may be used depending on content area. These include but are not limited to: lecture, multimedia, cooperative/collaborative learning, labs and demonstrations, projects and presentations, speeches, debates, and panels, conferencing, performances, and learning experiences outside the classroom. Methodology will be selected to best meet student needs.

COURSE OUTLINE:

All students must comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

I. High Voltage Electrical Safety
    A. Electric Shock
    B. Tool and Equipment Usage
    C. High Voltage Safety Rules
    D. Electrical Isolation
    E. Service Disconnect Switch Systems
    F. CAT III Environment
II. Gasoline Internal Combustion Engine hybrids
    A. Atkinson cycle
    B. Miller cycle
    C. Cylinder dropping
    D. Model specific designs
    E. Cooling systems
    F. Cold operation
    G. Service differences
III. Diesel internal combustion engine hybrids
    A. Clean diesel technology
    B. Vehicle specific designs
    C. Service differences
    D. Biodiesel
IV. Alternate fuel internal combustion engine hybrids
    A. CNG
    B. Natural gas
V. Mechanical hybrids
    A. Air compression
    B. Other mechanical systems
VI. Fuel cell hybrids
    A. Hydrogen cells
    B. Other types of cells

EXPECTED LEARNER OUTCOMES:

A. The student will be able to describe high voltage electrical safety
B. The student will be able to remove and install an HEV engine
C. The student will be able to explain the differences in hybrid gasoline internal combustion engines
D. The student will be able to perform diagnostics on HEV ICE
E. The student will be able to explain the operation of diesel internal combustion engines
F. The student will be able to explain other alternate fuel internal combustion engines
G. The student will be able to describe types of mechanical hybrids

H. The student will be able to explain operation of different types of fuel cell
I. hybrids

COURSE COMPETENCIES:

The student will be able to describe high voltage electrical safety

1. Define high voltage and explain the implications of human interaction
2. Explain the purpose of personal protection equipment and what they do
3. Demonstrate how to wear high voltage personal protection equipment
4. Demonstrate when and where personal protection equipment will be worn
5. Demonstrate how to disable high voltage

The student will be able to remove and install an HEV engine

6. Remove and install a HEV internal combustion engine (ICE)
7. Remove and install transmission from two types of HEV engines

The student will be able to explain the differences in hybrid gasoline internal combustion engines

8. Explain how the Atkinson cycle works
9. Explain how the Miller cycle Works
10. Describe cylinder dropping
11. Perform cylinder leakage and compression tests
12. Discuss some model specific design differences
13. Describe ICE cooling systems
14. Describe how cold operation differs from standard ICE
15. Explain what service differences are between ICE and HEV
16. Explain what differences are present for emission controls

The student will be able to perform diagnostics on HEV ICE

17. Perform cylinder leakage test and compression tests
18. Perform scantool diagnostics of base ICE controls
19. Perform model specific service diagnostics for two different vehicles

The student will be able to explain the operation of diesel internal combustion engines

20. Explain what makes clean diesel technology possible
21. Describe some of the vehicle specific designs in production
22. Describe service differences between diesel and other engines
23. Explain the advantages of biodiesel

The student will be able to explain other alternate fuel internal combustion engines

24. Explain advantages and disadvantages of natural gas
25. Explain advantages and disadvantages of ethanol and alcohol based fuels

The student will be able to describe types of mechanical hybrids

26. Describe how a air compression engine works
27. Describe other mechanical systems

The student will be able to explain operation of different types of fuel cell hybrids

28. Explain how a fuel cell works
29. Explain how other types of fuel cells could offer hope for future HEV

ASSESSMENT OF LEARNER OUTCOMES:

Assessment methods may include, but are not limited to, the following: Homework, Assignments, Quizzes, Class Participation, Chapter Tests, and Final Exam. The grading scale and the process for calculating the course grades are to be determined by the individual instructors. This information will be included in each instructor's syllabus.

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KANSAS CITY KANSAS COMMUNITY COLLEGE

COMPETENCY INDEX

Course Number/Section/Title: _AHEV 212 Hybrid Electric Vehicle Internal Combustion Engines and Alternate Power

Student Name: _____ Student Number:_____

Instructor: _____ Division: _____

RATING SCALE for Competency Achievement

4 Superior
3 Good
2 Average
1 Inferior
0 Failure
NA Not Addressed

DIRECTIONS:

Evaluate the student by checking or highlighting the appropriate number to indicate the degree of competency achieved.

Hybrid Electric Vehicle Internal Combustion Engines and Alternate Power

For every task in Hybrid Electric Vehicle Combustion Engines and Alternate Power, the following safety requirement must be strictly enforced:

Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

4 3 2 1 0 NA	1. Define high voltage and explain the implications of human interaction
4 3 2 1 0 NA	2. Explain the purpose of personal protection equipment and what they do
4 3 2 1 0 NA	3. Demonstrate how to wear high voltage personal protection equipment
4 3 2 1 0 NA	4. Demonstrate when and where personal protection equipment will be worn
4 3 2 1 0 NA	5. Demonstrate how to disable high voltage
4 3 2 1 0 NA	6. Remove and install a HEV internal combustion engine (ICE)

4 3 2 1 0 NA	7. Remove and install transmission from two types of HEV engines
4 3 2 1 0 NA	8. Explain how the Atkinson cycle works
4 3 2 1 0 NA	9. Explain how the Miller cycle Works
4 3 2 1 0 NA	10. Describe cylinder dropping
4 3 2 1 0 NA	11. Perform cylinder leakage and compression tests
4 3 2 1 0 NA	12. Discuss some model specific design differences
4 3 2 1 0 NA	13. Describe ICE cooling systems
4 3 2 1 0 NA	14. Describe how cold operation differs from standard ICE
4 3 2 1 0 NA	15. Explain what service differences are between ICE and HEV
4 3 2 1 0 NA	16. Explain what differences are present for emission controls
4 3 2 1 0 NA	17. Perform cylinder leakage test and compression tests
4 3 2 1 0 NA	18. Perform scantool diagnostics of base ICE controls
4 3 2 1 0 NA	19. Perform model specific service diagnostics for two different vehicles
4 3 2 1 0 NA	20. Explain what makes clean diesel technology possible
4 3 2 1 0 NA	21. Describe some of the vehicle specific designs in production
4 3 2 1 0 NA	22. Describe service differences between diesel and other engines
4 3 2 1 0 NA	23. Explain the advantages of biodiesel
4 3 2 1 0 NA	24. Explain advantages and disadvantages of natural gas
4 3 2 1 0 NA	25. Explain advantages and disadvantages of ethanol and alcohol based fuels
4 3 2 1 0 NA	26. Describe how a air compression engine works
4 3 2 1 0 NA	27. Describe other mechanical systems
4 3 2 1 0 NA	28. Explain how a fuel cell works
4 3 2 1 0 NA	29. Explain how other types of fuel cells could offer hope for future HEV

Please check one of the following:

_____I certify that the student completed the course and the competencies indicated as indicated.

_____I certify that the student completed 25% of the course competencies, as indicated.

Instructor Signature:
Date:

SYLLABUS

DATE OF LAST REVIEW : Spring 2010

CIP CODE: **47.0614**

SEMESTER: Departmental Syllabus

COURSE TITLE: Hybrid Electric Vehicle Transmissions

COURSE NUMBER: **AHEV 222**

CREDIT HOURS: 3

INSTRUCTOR: Departmental Syllabus

OFFICE LOCATION: Departmental Syllabus

OFFICE HOURS: Departmental Syllabus

TELEPHONE: Departmental Syllabus

EMAIL : Departmental Syllabus

PREREQUISITE(S): AUTT 262, AUTT 281 or approval by the instructor.

REQUIRED TEXT AND MATERIALS:
Please see bookstore for current textbook(s) and other required material.

COURSE DESCRIPTION:
The student will learn the theory and operation of hybrid drive systems in the automobile. The content will cover batteries, charging, high voltage safety, transmission, inverter/converter operation, cooling systems, diagnosis and repair of these advanced and unique automobiles. The course will emphasize the importance of safety due to the deadly nature of the high voltage environment. Students are required to purchase their own high voltage class 0 gloves to participate in live lab experiences.

METHOD OF INSTRUCTION:
A variety of instructional methods may be used depending on content area. These include but are not limited to: lecture, multimedia, cooperative/collaborative learning, labs and demonstrations, projects and presentations, speeches, debates, and panels, conferencing, performances, and learning experiences outside the classroom. Methodology will be selected to best meet student needs.

COURSE OUTLINE:
All students must comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

I. High Voltage Electrical Safety
    A. Electric Shock
    B. Tool and Equipment Usage and High Voltage Systems
    C. Electrical Isolation
    D. Multi-meters
    E. CAT III environment

II. Diagnostics
    A. Power flow of Toyota and Ford transmissions
    B. Power flow of popular rear wheel drive HEV transmissions
    C. Drive ratios between ICE and EM during different driving modes
    D. Information
    E. Scantool data
    F. Noise

III. Maintenance Service
    A. Lubrication
    B. Cooling systems
    C. Leaks
    D. Noise

IV. Series Hybrids Service
    A. Chevrolet Volt
    B. Other

V. Parallel Hybrids Service
    A. Honda IMA
    B. ISG
    C. Other systems

VI. Series Parallel Hybrid Service
    A. GM/BMW Two-Mode
    B. Toyota
    C. Ford
    D. Nissan
    E. Hyundai/Kia
    F. Mazda
    G. Other developments

VII. Removal and Installation
    A. Cautions
    B. Special tools
    C. Model specific
    D. Other issues

EXPECTED LEARNER OUTCOMES:

A. The student will be able to demonstrate understanding of high voltage electrical safety
B. The student will be able to explain diagnostics of hybrid vehicles
C. The student will be able to describe maintenance procedures
D. The student will be able to explain how to service series hybrids
E. The student will be able to demonstrate how to service parallel hybrid transmissions
F. The student will be able to demonstrate how to service series-parallel hybrid transmissions
G. The student will be able to demonstrate how to remove and install a hybrid transmission

COURSE COMPETENCIES:

The student will be able to demonstrate understanding of high voltage electrical safety

A. Define high voltage and explain the implications of human interaction
B. Explain the purpose of personal protection equipment and what they do
C. Demonstrate how to wear high voltage personal protection equipment
D. Explain when and where personal protection equipment will be worn
E. Explain how to disable high voltage

The student will be able to explain diagnostics of hybrid vehicles

F. Explain power flow through planetary gear sets in Toyota and Ford transmissions
G. Explain variations of power flow through 3 manufacturer specific rear wheel drive HEV transmissions
H. Explain how power ratios differ for different driving situations in each transmission type
I. Demonstrate how to read scan data from a hybrid vehicle
J. Explain what data is available for hybrid vehicle diagnostics
K. Obtain freeze frame data regarding EM operation

The student will be able to describe maintenance procedures

L. Check fluid level on a hybrid transmission
M. Explain how to service and bleed cooling systems on a hybrid transmission
N. Describe leak testing and service for common problems

The student will be able explain how to service series hybrids

O. Explain what components deliver power to the wheels of a series hybrid

The student will be able to demonstrate how to service hybrid components of a parallel hybrid transmission

P. Remove IMA components from a Honda
Q. Identify components of an IMA
R. Re-install components of an IMA

The student will be able to demonstrate how to service series-parallel hybrid transmissions

S. Demonstrate disassembly of two common series-parallel transmissions
T. Identify the names of the components

U. Explain what each component does
V. Test electrical components for insulation integrity
W. Assemble two common series-parallel transmissions

The student will be able to demonstrate how to remove and install a hybrid transmission

X. Remove and install a hybrid transmission from a vehicle
Y. The student will install a hybrid transmission into the vehicle

ASSESSMENT OF LEARNER OUTCOMES:
Assessment methods may include, but are not limited to, the following: Homework, Assignments, Quizzes, Class Participation, Chapter Tests, and Final Exam. The grading scale and the process for calculating the course grades are to be determined by the individual instructors. This information will be included in each instructor's syllabus.

SPECIAL NOTES:
This syllabus is subject to change at the discretion of the instructor. Material included is intended to provide an outline of the course and rules that the instructor will adhere to in evaluating the student's progress. However, this syllabus is not intended to be a legal contract. Questions regarding the syllabus are welcome any time.

Kansas City Kansas Community College is committed to an appreciation of diversity with respect for the differences among the diverse groups comprising our students, faculty, and staff that is free of bigotry and discrimination. Kansas City Kansas Community College is committed to providing a multicultural education and environment that reflects and respects diversity and that seeks to increase understanding.

Kansas City Kansas Community College offers equal educational opportunity to all students as well as serving as an equal opportunity employer for all personnel. Various laws, including Title IX of the Educational Amendments of 1972, require the college's policy on non-discrimination be administered without regard to race, color, age, sex, religion, national origin, physical handicap, or veteran status and that such policy be made known.

Kansas City Kansas Community College complies with the Americans with Disabilities Act. If you need accommodations due to a documented disability, please contact Valerie Webb, in Rm. 3354 or call at: 288-7670 V/TDD.

KANSAS CITY KANSAS COMMUNITY COLLEGE

COMPETENCY INDEX

Course Number/Section/Title: _AHEV 222 Hybrid Electric Vehicle Transmissions___

Student Name: _____ Student Number:_____

Instructor: _____ Division: _____

RATING SCALE for Competency Achievement

4 Superior
3 Good
2 Average
1 Inferior
0 Failure
NA Not Addressed

DIRECTIONS:

Evaluate the student by checking or highlighting the appropriate number to indicate the degree of competency achieved.

Hybrid Electric Vehicle Transmissions

For every task in Hybrid Electric Vehicle Transmissions, the following safety requirement must be strictly enforced:

Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

4 3 2 1 0 NA	1. Define high voltage and explain the implications of human interaction
4 3 2 1 0 NA	2. Explain the purpose of personal protection equipment and what each does
4 3 2 1 0 NA	3. Demonstrate how to wear high voltage personal protection equipment
4 3 2 1 0 NA	4. Explain when and where personal protection equipment will be worn
4 3 2 1 0 NA	5. Explain how to disable high voltage
4 3 2 1 0 NA	6. Explain power flow through planetary gear sets in Toyota and Ford transmissions
4 3 2 1 0 NA	7. Explain how power ratios differ for different driving situations in

	each transmission type
4 3 2 1 0 NA	8. Demonstrate how to read scan data from a hybrid vehicle
4 3 2 1 0 NA	9. Explain variations of power flow through 3 manufacturer specific rear wheel drive HEV transmissions
4 3 2 1 0 NA	10. Explain what data is available for hybrid vehicle diagnostics
4 3 2 1 0 NA	11. Obtain freeze frame data regarding EM operation
4 3 2 1 0 NA	12. Check fluid level on a hybrid transmission
4 3 2 1 0 NA	13. Explain how to service and bleed cooling systems on a hybrid transmission
4 3 2 1 0 NA	14. Describe leak testing and service for common problems
4 3 2 1 0 NA	15. Explain what components deliver power to the wheels of a series hybrid
4 3 2 1 0 NA	16. Remove IMA components from a Honda
4 3 2 1 0 NA	17. Identify components of an IMA
4 3 2 1 0 NA	18. Re-install components of an IMA
4 3 2 1 0 NA	19. Demonstrate disassembly of two common series-parallel transmissions
4 3 2 1 0 NA	20. Identify the names of the components
4 3 2 1 0 NA	21. Explain what each component does
4 3 2 1 0 NA	22. Test electrical components for insulation integrity
4 3 2 1 0 NA	23. Assemble two common series-parallel transmissions
4 3 2 1 0 NA	24. Remove a hybrid transmission from a vehicle
4 3 2 1 0 NA	25. Install a hybrid transmission into a vehicle

Please check one of the following:

_____I certify that the student completed the course and the competencies indicated as indicated.

_____I certify that the student completed 25% of the course competencies, as indicated.

Instructor Signature:

Date:

SYLLABUS

DATE OF LAST REVIEW : Spring 2010

CIP CODE: **47.0614**

SEMESTER: Departmental Syllabus

COURSE TITLE: **Hybrid Electric Vehicle Batteries**

COURSE NUMBER: **AHEV 262**

CREDIT HOURS: 3

INSTRUCTOR: Departmental Syllabus

OFFICE LOCATION: Departmental Syllabus

OFFICE HOURS: Departmental Syllabus

TELEPHONE: Departmental Syllabus

EMAIL : Departmental Syllabus

PREREQUISITE(S): AUTT 262, AUTT 282 or approval by the instructor.

REQUIRED TEXT AND MATERIALS:
Please see bookstore for current textbook(s) and other required material.

COURSE DESCRIPTION:
The student will learn the theory and operation of batteries in hybrid electric, electric and plug in hybrid vehicles. The content will cover battery safety, cooling systems, diagnosis and service. The course will emphasize the importance of safety due to the deadly nature of the high voltage environment. Students are required to purchase their own high voltage class 0 gloves to participate in live lab experiences.

METHOD OF INSTRUCTION:
A variety of instructional methods may be used depending on content area. These include but are not limited to: lecture, multimedia, cooperative/collaborative learning, labs and demonstrations, projects and presentations, speeches, debates, and panels, conferencing, performances, and learning experiences outside the classroom. Methodology will be selected to best meet student needs.

COURSE OUTLINE:

All students must comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

I. High Voltage Electrical Safety
    A. Electric shock
    B. Tool and equipment usage and high voltage systems
    C. Electrical isolation
    D. Multimeters
    E. CAT III
II. High Voltage Vehicle Safety Systems
    A. Serial Interlock Loop (SIL)
    B. Local Interlock Loop (LIP)
    C. Service disconnect switch systems
    D. High voltage isolation fault detection
    E. Testing for isolation faults
III. DC-DC Converter Systems
    A. The Fundamentals of dc-dc converter operation
IV. Battery Cooling Systems
    A. Temperature sensors
    B. Model specific cooling systems
V. Battery Management Systems
    A. Battery interconnection
    B. Battery pack to power inverter cabling
    C. Battery pack current sensing
    D. Battery pack contactors (Relays)
    E. The battery pack controller
    F. Diagnostics
VI. Plug in Hybrid Electric Vehicles or PHEV
    A. Characteristics of PHEV operation
    B. Off the car charging stations
    C. Power variations from the charging station to the vehicle
    D. Components of the PHEV system
    E. Supply power from the power company
    F. Issues with modifications for the consumers home to supply power
VII. Battery Construction
    A. Lead acid battery families (Flooded and AGM)
    B. Principles of flooded and AGM battery technologies
    C. Basic flooded battery technology
    D. Connecting batteries in series and parallel
    E. Service including proper replacement methods
    F. Disassembly of the battery module for component replacement
VIII. High Voltage Nickel Metal Hydride Technology
    A. Charge and discharge electrical characteristics
    B. Capacity and specifications

C. Advantages and disadvantages
D. Service

IX. High Voltage Lithium Based Batteries
A. Charge and discharge electrical characteristics
B. Capacity and specifications
C. Advantages and disadvantages
D. Service

X. High Voltage Batteries of other designs
A. Sodium
B. Zinc
C. Other

XI. Other Related
A. Ultra capacitors
B. Future of battery technology

EXPECTED LEARNER OUTCOMES:

A. The student will be able to demonstrate high voltage electrical safety procedures
B. The student will be able to describe the high voltage vehicle safety systems
C. The student will be able to explain how DC-DC converter systems work
D. The student will be able to explain how battery cooling systems work
E. The student will be able to explain battery management systems work
F. The student will be able to describe battery construction
G. The student will be able to demonstrate service on high voltage nickel metal hydride technology
H. The student will be able to demonstrate service on high voltage lithium based batteries
I. The student will be able to discuss batteries of other designs
J. The student will be able to discuss other HEV battery related information

COURSE COMPETENCIES:

The student will be able to demonstrate high voltage electrical safety procedures

1. Define high voltage and explain the implications of human interaction
2. Explain the purpose of personal protection equipment and what they do
3. Demonstrate how to wear high voltage personal protection equipment
4. Demonstrate when and where personal protection equipment will be worn
5. Demonstrate how to disable high voltage

The student will be able to describe the high voltage vehicle safety systems

6. Demonstrate the coupling and uncoupling of the interlock loop
7. Demonstrate proper disconnect/reconnect procedure of the service disconnect
8. Demonstrate testing for isolation faults

The student will be able to explain how DC-DC converter systems work

9. Explain how the dc to dc converter works and why
10. Describe how the converter charges the low voltage battery

The student will be able to explain how battery cooling systems work

11. Demonstrate temperature sensor output on scan tool

12. Describe how battery cooling systems work on three common hybrid vehicles

    The student will be able to explain battery management systems work

13. Demonstrate battery cable removal procedures
14. Explain operation of battery pack contactors
15. Describe current sensing PIDs from scantool
16. Identify battery pack controller and its operation
17. Demonstrate procedure for scanning vehicle modules for data

    The student will be able to understand the Plug in Hybrid Electric Vehicle or PHEV

18. Explain the characteristics of PHEV operation
19. Explain off the car charging station power requirements for the consumer
20. Explain power variations from the charging station to the vehicle
21. Explain components of the PHEV system
22. Explain issues with power grids and supply power from the power company
23. Explain issues with modifications for the consumers home to supply power

    The student will be able to describe battery construction

24. Demonstrate basic testing for high and low voltage batteries
25. Demonstrate high and low voltage battery bus connection methods
26. Demonstrate high and low voltage battery replacement methods
27. Disassemble and reassemble a complete battery module

    The student will be able to demonstrate service on high voltage nickel metal hydride technology

28. Explain the characteristics of charging and discharging while in normal operation
29. Describe the advantages and disadvantages of nickel metal hydride batteries
30. Demonstrate battery removal and installation

    The student will be able to demonstrate service on high voltage lithium based batteries

31. Explain the characteristics of normal charging and discharging
32. Discuss the specifications and types of lithium batteries
33. Explain the advantages and disadvantages of lithium
34. Describe service techniques for lithium batteries

    The student will be able to discuss batteries of other designs

35. Describe issues with batteries that use Sodium, Zinc and other types of material

    The student will be able to discuss other HEV battery related information

36. Explain how ultra capacitors can take the place of batteries
37. Discuss the future of battery technology
38. Describe how to dispose of hazardous material
39. Describe how to deal with batteries that are damaged

ASSESSMENT OF LEARNER OUTCOMES:
Assessment methods may include, but are not limited to, the following: Homework, Assignments, Quizzes, Class Participation, Chapter Tests, and Final Exam. The grading scale and the process for calculating the course grades are to be determined by the individual instructors. This information will be included in each instructor's syllabus.

SPECIAL NOTES:

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Kansas City Kansas Community College offers equal educational opportunity to all students as well as serving as an equal opportunity employer for all personnel. Various laws, including Title IX of the Educational Amendments of 1972, require the college's policy on non-discrimination be administered without regard to race, color, age, sex, religion, national origin, physical handicap, or veteran status and that such policy be made known.

Kansas City Kansas Community College complies with the Americans with Disabilities Act. If you need accommodations due to a documented disability, please contact Valerie Webb, in Rm. 3354 or call at: 288-7670 V/TDD.

KANSAS CITY KANSAS COMMUNITY COLLEGE

COMPETENCY INDEX

Course Number/Section/Title: _AHEV 262 Hybrid Electric Vehicle Batteries__

Student Name: _____ Student Number:_____

Instructor: _____ Division: _____

RATING SCALE for Competency Achievement

4 Superior
3 Good
2 Average
1 Inferior
0 Failure
NA Not Addressed

DIRECTIONS:

Evaluate the student by checking or highlighting the appropriate number to indicate the degree of competency achieved.

Hybrid Electric Vehicle Batteries

For every task in Hybrid Electric Vehicle Batteries, the following safety requirement must be strictly enforced:

Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

4 3 2 1 0 NA	1. Define high voltage and explain the implications of human interaction
4 3 2 1 0 NA	2. Explain the purpose of personal protection equipment and what they do
4 3 2 1 0 NA	3. Demonstrate how to wear high voltage personal protection equipment
4 3 2 1 0 NA	4. Demonstrate when and where personal protection equipment will be worn
4 3 2 1 0 NA	5. Demonstrate how to disable high voltage
4 3 2 1 0 NA	6. Demonstrate the coupling and uncoupling of the interlock loop
4 3 2 1 0 NA	7. Demonstrate proper disconnect/reconnect procedure of the service disconnect
4 3 2 1 0 NA	8. Demonstrate testing for isolation faults
4 3 2 1 0 NA	9. Explain how the dc to dc converter works and why

4 3 2 1 0 NA	10. Describe how the converter charges the low voltage battery
4 3 2 1 0 NA	11. Demonstrate temperature sensor output on scan tool
4 3 2 1 0 NA	12. Describe how battery cooling systems work on three common hybrid vehicles
4 3 2 1 0 NA	13. Demonstrate battery cable removal procedures
4 3 2 1 0 NA	14. Explain operation of battery pack contactors
4 3 2 1 0 NA	15. Describe current sensing PIDs from scan-tool
4 3 2 1 0 NA	16. Identify battery pack controller and its operation
4 3 2 1 0 NA	17. Demonstrate procedure for scanning vehicle modules for data
4 3 2 1 0 NA	18. Explain the characteristics of PHEV operation
4 3 2 1 0 NA	19. Explain off the car charging station power requirements for the consumer
4 3 2 1 0 NA	20. Explain power variations from the charging station to the vehicle
4 3 2 1 0 NA	21. Explain components of the PHEV system
4 3 2 1 0 NA	22. Explain issues with power grids and supply power from the power company
4 3 2 1 0 NA	23. Explain issues with modifications for the consumers home to supply power
4 3 2 1 0 NA	24. Demonstrate basic testing for high and low voltage batteries
4 3 2 1 0 NA	25. Demonstrate high and low voltage battery bus connection methods
4 3 2 1 0 NA	26. Demonstrate high and low voltage battery replacement methods
4 3 2 1 0 NA	27. Disassemble and reassemble a complete battery module
4 3 2 1 0 NA	28. Explain the characteristics of charging and discharging while in normal operation
4 3 2 1 0 NA	29. Describe the advantages and disadvantages of nickel metal hydride batteries
4 3 2 1 0 NA	30. Demonstrate battery removal and installation
4 3 2 1 0 NA	31. Explain the characteristics of normal charging and discharging
4 3 2 1 0 NA	32. Discuss the specifications and types of lithium batteries
4 3 2 1 0 NA	33. Explain the advantages and disadvantages of lithium
4 3 2 1 0 NA	34. Describe service techniques for lithium batteries
4 3 2 1 0 NA	35. Describe issues with batteries that use Sodium, Zinc and other types of material
4 3 2 1 0 NA	36. Explain how ultra capacitors can take the place of batteries
4 3 2 1 0 NA	37. Discuss the future of battery technology
4 3 2 1 0 NA	38. Describe how to dispose of hazardous material
4 3 2 1 0 NA	39. Describe how to deal with damaged HV batteries

Please check one of the following:

_____I certify that the student completed the course and the competencies indicated as indicated.

_____I certify that the student completed 25% of the course competencies, as indicated.

Instructor Signature:

Date:

SYLLABUS

DATE OF LAST REVIEW : Spring 2010

CIP CODE: **47.0614**

SEMESTER: Departmental Syllabus

COURSE TITLE: Hybrid Electric Vehicle Accessories

COURSE NUMBER: **AHEV 265**

CREDIT HOURS: 3

INSTRUCTOR: Departmental Syllabus

OFFICE LOCATION: Departmental Syllabus

OFFICE HOURS: Departmental Syllabus

TELEPHONE: Departmental Syllabus

EMAIL : Departmental Syllabus

PREREQUISITE(S): AUTT 262, AUTT 282 or approval by the instructor.

REQUIRED TEXT AND MATERIALS:
Please see bookstore for current textbook(s) and other required material.

COURSE DESCRIPTION:
The student will learn the theory and operation of hybrid, electric, and plug in hybrid accessories including electric power steering, electric air conditioning, electric coolant pumps and other devices. Understanding of the DC to DC converter and charging system will also be discussed. The course will emphasize the importance of safety due to the deadly nature of the high voltage environment. Students are required to purchase their own high voltage class 0 gloves to participate in live lab experiences.

METHOD OF INSTRUCTION:
A variety of instructional methods may be used depending on content area. These include but are not limited to: lecture, multimedia, cooperative/collaborative learning, labs and demonstrations, projects and presentations, speeches, debates, and panels, conferencing, performances, and learning experiences outside the classroom. Methodology will be selected to best meet student needs.

COURSE OUTLINE:
All students must comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

I. High Voltage Electrical Safety
    A. Electric Shock
    B. Tool and Equipment Usage
    C. High Voltage Safety Rules
    D. Electrical Isolation
    E. Multimeters
    F. CAT III
    G. Service Disconnect Systems
II. DC-DC Converter Systems
    A. The fundamentals of dc-dc converter operation
    B. Battery Charging
    C. Low voltage power for accessories
III. Hybrid Climate Control Systems
    A. Electric compressors
    B. Electric A/C compressor power inverter
    C. Combination electric and belt drive compressors
    D. Hybrid heating systems
    E. Auxiliary pump operation during engine idle off mode
    F. Refrigerant oil conductivity
    G. Diagnosis and repair
IV. Steering Assist
    A. Electro-hydraulic power steering systems
    B. Electric power assist
    C. Diagnosis and repair
V. Driver Information Center
    A. Model specific operations
    B. Understanding data
VI. Brake systems
    A. Power brake assist
    B. Electric braking
    C. Diagnosis
VII. Plug in Hybrid Electric Vehicle (PHEV)
    A. Off car charging systems
    B. On car charging systems that plug into off car power
    C. Home power requirements and the grid
    D. Components of PHEV's
    E. Diagnostics of PHEV's
VIII. Other Systems
    A. Various types of cooling system components
    B. Pumps

C. Bleeding cooling systems
D. Key off cooling systems
E. Special fluids
F. Various model specific accessories

EXPECTED LEARNER OUTCOMES:

A. The student will be able to describe in detail high voltage electrical safety
B. The student will be able to explain DC-DC converter systems
C. The student will be able to describe hybrid climate control systems
D. The student will be able to describe power steering
E. The student will be able to explain the instrument panel features
F. The student will be able to describe brakes for a hybrid electric vehicle
G. The student will be able to describe Plug in Hybrid Electric Vehicle (PHEV) operation
H. The student will be able to explain other systems

COURSE COMPETENCIES:

The student will be able to describe in detail high voltage electrical safety

1. Define high voltage and explain the implications of human interaction
2. Explain the purpose of personal protection equipment and what they do
3. Demonstrate how to wear high voltage personal protection equipment
4. Demonstrate when and where personal protection equipment will be worn
5. Demonstrate how to disable high voltage

The student will be able to explain DC-DC converter systems

6. Explain how the dc to dc converter works and why
7. Describe cycle outputs from the DC to DC converter
8. Remove and install a DC-DC converter
9. Diagnose DC-DC a converter using a scantool

The student will be able to describe hybrid climate control systems

10. Describe how electric compressors work
11. Describe how the A/C compressor power inverter works
12. Describe how electric and drive belt compressors work
13. Explain refrigerant oil conductivity
14. Explain compressor speed controls
15. Remove and install compressor

The student will be able to describe power steering

16. Explain how an electric hybrid power steering system works
17. Describe two types of hybrid power steering systems
18. Demonstrate diagnosis of power steering with a scantool

The student will be able to explain the instrument panel features

19. Describe model specific features of driver information centers
20. Describe gearshift operation and park control

The student will be able to describe brakes for a hybrid electric vehicle

21. Demonstrate how to bleed brakes with a scantool
22. Demonstrate how to enter service mode for brake service
23. Describe operation of power brake assist

The student will be able to describe Plug in Hybrid Electric Vehicle (PHEV)

24. Explain the operation of off car charging systems
25. Explain on board car charging systems that plug into off car power
26. Discuss power requirements for the home issues regarding the power grid
27. Describe the components of PHEV's
28. View scantool data showing information from off car charging system

The student will be able to explain other systems

29. Describe cooling system variations on different hybrid vehicles
30. Demonstrate techniques for bleeding a cooling system
31. Identify special fluids for use in a hybrid electric vehicle
32. Explain the operation of key off cooling systems

ASSESSMENT OF LEARNER OUTCOMES:
Assessment methods may include, but are not limited to, the following: Homework, Assignments, Quizzes, Class Participation, Chapter Tests, and Final Exam. The grading scale and the process for calculating the course grades are to be determined by the individual instructors. This information will be included in each instructor's syllabus.

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KANSAS CITY KANSAS COMMUNITY COLLEGE

COMPETENCY INDEX

Course Number/Section/Title: __AUTH 265_Hybrid Electric Vehicle Accessories_____

Student Name: _____ Student Number:_____

Instructor: _____ Division: _____

RATING SCALE for Competency Achievement

4 Superior
3 Good
2 Average
1 Inferior
0 Failure
NA Not Addressed

DIRECTIONS:

Evaluate the student by checking or highlighting the appropriate number to indicate the degree of competency achieved.

Hybrid Electric Vehicle Accessories

For every task in Hybrid Electric Vehicle Accessories, the following safety requirement must be strictly enforced:

Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

4 3 2 1 0 NA	1. Define high voltage and explain the implications of human interaction
4 3 2 1 0 NA	2. Explain the purpose of personal protection equipment and what they do
4 3 2 1 0 NA	3. Demonstrate how to wear high voltage personal protection equipment
4 3 2 1 0 NA	4. Demonstrate when and where personal protection equipment will be worn
4 3 2 1 0 NA	5. Demonstrate how to disable high voltage
4 3 2 1 0 NA	6. Explain how the dc to dc converter works and why
4 3 2 1 0 NA	7. Describe cycle outputs from the DC to DC converter
4 3 2 1 0 NA	8. Remove and install a DC-DC converter
4 3 2 1 0 NA	9. Diagnose DC-DC a converter using a scantool
4 3 2 1 0 NA	10. Describe how electric compressors work
4 3 2 1 0 NA	11. Describe how the A/C compressor power inverter works

4 3 2 1 0 NA	12. Describe how electric and drive belt compressors work
4 3 2 1 0 NA	13. Explain refrigerant oil conductivity
4 3 2 1 0 NA	14. Explain compressor speed controls
4 3 2 1 0 NA	15. Remove and install compressor
4 3 2 1 0 NA	16. Explain how an electric hybrid power steering system works
4 3 2 1 0 NA	17. Describe two types of hybrid power steering systems
4 3 2 1 0 NA	18. Demonstrate diagnosis of power steering with a scantool
4 3 2 1 0 NA	19. Describe model specific features of driver information centers
4 3 2 1 0 NA	20. Describe gearshift operation and park control
4 3 2 1 0 NA	21. Demonstrate how to bleed brakes with a scantool
4 3 2 1 0 NA	22. Demonstrate how to enter service mode for brake service
4 3 2 1 0 NA	23. Describe operation of power brake assist
4 3 2 1 0 NA	24. Explain the operation of off car charging systems
4 3 2 1 0 NA	25. Explain on board car charging systems that plug into off car power
4 3 2 1 0 NA	26. Discuss power requirements for the home issues regarding the power gric
4 3 2 1 0 NA	27. Describe the components of PHEV's
4 3 2 1 0 NA	28. View scantool data showing information from off car charging system
4 3 2 1 0 NA	29. Describe cooling system variations on different hybrid vehicles
4 3 2 1 0 NA	30. Demonstrate techniques for bleeding a cooling system
4 3 2 1 0 NA	31. Identify special fluids for use in a hybrid electric vehicle
4 3 2 1 0 NA	32. Explain the operation of key off cooling systems

Please check one of the following:

_____I certify that the student completed the course and the competencies indicated as indicated.

_____I certify that the student completed 25% of the course competencies, as indicated.

Instructor Signature:

Date:

SYLLABUS

DATE OF LAST REVIEW : Spring 2010

CIP CODE: **47.0614**

SEMESTER: Departmental Syllabus

COURSE TITLE: Hybrid /Electric Vehicles Inverters, Converters and Electric Motors

COURSE NUMBER: AHEV **282**

CREDIT HOURS: 3

INSTRUCTOR: Departmental Syllabus

OFFICE LOCATION: Departmental Syllabus

OFFICE HOURS: Departmental Syllabus

TELEPHONE: Departmental Syllabus

EMAIL : Departmental Syllabus

PREREQUISITE(S): AUTT 262, AUTT 282 or approval by the instructor.

REQUIRED TEXT AND MATERIALS:
Please see bookstore for current textbook(s) and other required material.

COURSE DESCRIPTION:
The student will learn the theory and operation of electric motors, converters, inverters and chargers used to power hybrid, electric, and plug in hybrid vehicles. The course will emphasize the importance of safety due to the deadly nature of the high voltage environment. Students are required to purchase their own high voltage class 0 gloves to participate in live lab experiences.

METHOD OF INSTRUCTION:
A variety of instructional methods may be used depending on content area. These include but are not limited to: lecture, multimedia, cooperative/collaborative learning, labs and demonstrations, projects and presentations, speeches, debates, and panels, conferencing, performances, and learning experiences outside the classroom. Methodology will be selected to best meet student needs.

COURSE OUTLINE:
All students must comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

I. High Voltage Electrical Safety
    A. Electric shock
    B. Tool and equipment usage
    C. High voltage safety rules
    D. Electrical isolation
    E. Service disconnect switch systems
    F. CAT III environment
II. AC theory
    A. Sine-wave
    B. Frequency
    C. Amplitude
    D. Inductance
    E. Capacitance
    F. Diode operation
    G. Transistor operation
    H. rectification
III. Motor Design categories
    A. Series design
    B. Parallel design
    C. Series parallel design
    D. BAS design
    E. Electric vehicles
    F. DC motors
    G. AC motors
    H. Traction and motor generators
IV. AC Induction Motor Components
    A. Electric vehicle system components
    B. Rotor and stator
    C. IM components
    D. Mutual induction
V. Power Inverter Systems
    A. Motor controls
    B. Power inverter
    C. Hybrid and electric power systems
    D. Motor power control strategies
    E. PWM sine waves
    F. Waveforms
    G. Regenerative braking
    H. Charging reactor

VI. Operation of three-phase AC motors
    A. Field interaction
    B. Motor controllers
    C. Motor control theory
VII. Sensing Systems
    A. Motor speed sensing
    B. Resolver
    C. Motor load current sensing
    D. Throttle pedal position sensing
VIII. Plug in Hybrid Electric Vehicle (PHEV)
    A. Explain on board car charging systems that plug into off car power
    B. Home power requirements
    C. Components of PHEV's
    D. View scantool data from charging system
IX. Electric motor and power inverter cooling
    A. Cooling system types by model
    B. Why we need cooling on inverter

EXPECTED LEARNER OUTCOMES:

A. The student will be able to explain the elements of high voltage electrical safety
B. The student will be able to describe electrical and AC theory
C. The student will be able to identify motor design categories
D. The student will be able to identify AC motor components
E. The student will be able to describe the operation of three-phase AC brushless electric motors
F. The student will be able to describe characteristics of sensing systems
G. The student will be able to describe Plug in Hybrid Electric Vehicle (PHEV) operation and service
H. The student will be able to explain motor and power inverter cooling

COURSE COMPETENCIES:

The student will be able to explain the elements of high voltage electrical safety

1. Define high voltage and explain the implications of human interaction
2. Demonstrate correct usage of tools and equipment
3. Understand the rules for high voltage
4. Demonstrate how to wear high voltage personal protection equipment
5. Demonstrate how to identify and use service disconnect systems

The student will be able to describe electrical and AC theory

6. Define sine-wave, frequency, amplitude, inductance, and capacitance
7. Explain diode operation, transistor operation and rectification

The student will be able to identify motor design categories

8. Explain the differences between series, parallel and series parallel systems
9. Explain the operation of DC motors and their use
10. Explain the operation of three-phase AC motors and their use
11. Define traction motor and motor generator

The student will be able to identify AC motor components

12. Remove and install electric motors from a transmission case
13. Remove and install the rotor and stator from an electric motor
14. Identify and describe associated motor components

The student will be able to describe the operation of three-phase AC brushless electric motors

15. Describe induction and field interaction

2 Explain the operation of the motor controller

3 Explain how motor controls interact with the electric motor

The student will be able to describe characteristics of sensing systems

4 Describe the purpose of a resolver

5 Explain the use of motor load current sensing

6 Explain how motor speed sensing occurs and why it is necessary

7 Measure and explain throttle pedal position sensing

The student will be able to describe the operation of power inverter systems

22. Explain how motor controls interact with the electric motor
23. Explain how a power inverter interacts with the battery and electric motors
24. Remove and install a inverter system and examine components
25. Describe motor control strategies
26. Read and interpret pulse width modulation and sine wave structures
27. Describe the use of wave forms
28. Describe how regenerative braking works in different vehicles

The student will be able to describe Plug in Hybrid Electric Vehicle (PHEV) operation and service

29 Explain on board car charging systems that plug into off car power

30 Discuss power requirements for the home issues regarding use of the power grid

31 Describe the components of PHEV's

32 View scantool data showing information from off car charging system

The student will be able to explain motor and power inverter cooling

33 Remove and install components of a inverter cooling system

34 Explain why cooling systems are necessary

ASSESSMENT OF LEARNER OUTCOMES:

Assessment methods may include, but are not limited to, the following: Homework, Assignments, Quizzes, Class Participation, Chapter Tests, and Final Exam. The grading scale and the process for calculating the course grades are to be determined by the individual instructors. This information will be included in each instructor's syllabus.

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KANSAS CITY KANSAS COMMUNITY COLLEGE

COMPETENCY INDEX

Course Number/Section/Title: AHEV 282 Hybrid /Electric Vehicle Inverters, Converters, and Electric Motors

Student Name: _____ Student Number:_____

Instructor: _____ Division: _____

RATING SCALE for Competency Achievement

4 Superior
3. Good
2 Average
1 Inferior
0 Failure
NA Not Addressed

DIRECTIONS:

Evaluate the student by checking or highlighting the appropriate number to indicate the degree of competency achieved.

Hybrid /Electric Vehicles Inverters Converters and Electric Motors

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4 3 2 1 0 NA	1. Define high voltage and explain the implications of human interaction
4 3 2 1 0 NA	2. Demonstrate correct usage of tools and equipment
4 3 2 1 0 NA	3. Understand the rules for high voltage
4 3 2 1 0 NA	4. Demonstrate how to wear high voltage personal protection equipment
4 3 2 1 0 NA	5. Demonstrate how to identify and use service disconnect systems
4 3 2 1 0 NA	6. Define sine-wave, frequency, amplitude, inductance, and capacitance
4 3 2 1 0 NA	7. Explain diode operation, transistor operation and rectification
4 3 2 1 0 NA	8. Explain the differences between series, parallel and series parallel systems
4 3 2 1 0 NA	9. Explain the operation of DC motors and their use
4 3 2 1 0 NA	10. Explain the operation of three-phase AC motors and their use

4 3 2 1 0 NA	11. Define traction motor and motor generators
4 3 2 1 0 NA	12. Remove and install electric motors from a transmission case
4 3 2 1 0 NA	13. Remove and install the rotor and stator from an electric motor
4 3 2 1 0 NA	14. Identify and describe associated motor components
4 3 2 1 0 NA	15. Describe induction and field interaction
4 3 2 1 0 NA	16 Explain the operation of the motor controller
4 3 2 1 0 NA	17 Explain how motor controls interact with the electric motor
4 3 2 1 0 NA	18 Describe the purpose of a resolver
4 3 2 1 0 NA	19 Explain the use of motor load current sensing
4 3 2 1 0 NA	20 Explain how motor speed sensing occurs and why it is necessary
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4 3 2 1 0 NA	32 View scantool data showing information from off car charging system
4 3 2 1 0 NA	33 Remove and install components of a inverter cooling system
4 3 2 1 0 NA	34 Explain why cooling systems are necessary

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Instructor Signature:

Date: