Course Summary:
This course addresses the fundamental electrochemistry and design aspects for secondary batteries for electric propulsion applications at battery cell, module, and system levels. A descriptive overview of battery technologies including lead acid, nickel metal hydride, and lithium ion batteries will be provided together with their application to hybrid and electric vehicle applications.

Specific Course Objectives:
• See the promise as well as the technological barriers to be overcome for batteries to lead to more widespread utilization of electric propulsion
• Describe and explain the performance requirements of various types of electric and hybrid vehicles
• Understand the energy and power capability of various battery chemistry couples and the impact of battery design
• Understand battery failure modes and their effect on battery life and safety
• Understand battery manufacturing and cost issues
• Design battery packs to meet hybrid and electric vehicle requirements based on cell and module performance specifications
• Evaluate and prioritize emerging battery technologies and products for specific electric and hybrid vehicle applications

PREREQUISITES: Senior standing in the science or engineering disciplines.

INSTRUCTOR: Dr. Dennis Corrigan
Contact by email corrigan@wyane.edu or cell phone 248-854-6583

OFFICE HOURS: Monday & Wednesday, 3-4 pm, 1124 ENGG

TEXTBOOK:

OTHER USEFUL REFERENCES:
RESPONSIBILITY:
The student will be responsible for all lecture material, class participation, advance reading assignments, completion of homework and quizzes, completion of the term project, and the midterm and final exam.

HOMEWORK:
Homework will be due one week after assignment. Late homework will not be accepted. Outright copying of homework or any unethical conduct in completing and submitting your homework will be prosecuted according to the cheating policy of the College and the University.

TERM PROJECT:
The term project will be a team engineering assignment to be performed by groups of 2-4 students working as a team. A team presentation of completed work is required upon completion of the project.

EXAMS:
Exams and quizzes will be closed book. Make-up exams will be given only by prior arrangement and only for valid reasons. College policy states that anyone giving or receiving information during an exam will be given an immediate failing grade for the course.

GRADING:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Homework and quizzes</td>
<td>25%</td>
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<tr>
<td>Mid-Term</td>
<td>25%</td>
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<tr>
<td>Term Project</td>
<td>25%</td>
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<tr>
<td>Final Exam</td>
<td>25%</td>
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Grade scale:
- A >90 %
- B 80-90 %
- C 70-80 %
- D 60-70 %
- F <60 %
TENTATIVE COURSE OUTLINE

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
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<tbody>
<tr>
<td>May 11</td>
<td>Introduction to Electric and Hybrid Vehicles</td>
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<tr>
<td>May 13</td>
<td>Introduction to Batteries – Part 1</td>
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<tr>
<td>May 18</td>
<td>“Who Killed the Electric Vehicle?”</td>
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<tr>
<td>May 20</td>
<td>Introduction to Batteries – Part 2</td>
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<tr>
<td>May 27</td>
<td>Lead Acid Batteries</td>
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<td>May 29</td>
<td>Nickel-Metal Hydride Batteries</td>
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<tr>
<td>Jun  1</td>
<td>Lithium Ion Batteries</td>
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<tr>
<td>Jun  3</td>
<td>Review</td>
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<tr>
<td>Jun  8</td>
<td><strong>Midterm Exam</strong></td>
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<tr>
<td>Jun 10</td>
<td>Guest Speaker</td>
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<td>Jun 15</td>
<td>Alternative Concepts – Fuel Cells and Ultracapacitors</td>
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<td>Jun 17</td>
<td>Alternative Concepts – Flow Batteries and High Temperature Batteries</td>
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<td>Jun 22</td>
<td>Vehicle Integration</td>
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<td>Jun 24</td>
<td>Vehicle Integration</td>
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<td>Jun 29</td>
<td>Project Discussions and Workshop</td>
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<td>Jul  1</td>
<td>Project Discussions and Workshop</td>
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<td>Jul  6</td>
<td>FMEA, Life, and Safety</td>
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<td>Jul  8</td>
<td>Manufacturing and Cost Analysis</td>
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<td>Jul 13</td>
<td>Project Discussions and Workshop</td>
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<td>Jul 15</td>
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<td>Jul 22</td>
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<td>Jul 29</td>
<td>Review</td>
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<tr>
<td>Aug  3</td>
<td><strong>Final Exam</strong></td>
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**Reading Assignments (to be completed in May prior to midterm exam)**

Kiehne, Battery Handbook (text)
  Chapters 1 (General + PbA, NiMH), 17 (PbA), 18 (Li-Ion)

Linden, Handbook of Batteries:
  Chapters 1 (General), 23+24 (PbA), 29+30 (NiMH), 35 (Li-Ion)