PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF AN UNDERGRADUATE COURSE
(100-400 LEVEL)

DEPARTMENT: Motorsports Engineering  EFFECTIVE SESSION: Fall 2009

INSTRUCTIONS: Please check the items below which describe the purpose of this request:
1. New course with supporting documents
2. Add existing course offered at another campus
3. Expiration of a course
4. Change in course number
5. Change in course title
6. Change in course credit/type
7. Change in course attributes (department head signature only)
8. Change in instructional hours
9. Change in course description
10. Change in course requisites
11. Change in semesters offered (department head signature only)
12. Transfer from one department to another

PROPOSED:
Subject Abbreviation: MSIE
Course Number: 490
Long Title: Automotive Control
Short Title: Automotive Control

EXISTING:
Subject Abbreviation: 
Course Number: 
Long Title: Automotive Control
Short Title: Automotive Control

TERMS OFFERED:
Check All That Apply:
- Summer
- Fall
- Spring

CAMPUS(ES) INVOLVED:
- Calumet
- Cont Ed
- Ft. Wayne
- Indianapolis
- N. Central
- Tech Statewide
- W. Lafayette

<table>
<thead>
<tr>
<th>CREDIT TYPE</th>
<th>COURSE ATTRIBUTES: Check All That Apply</th>
<th>COURSE DESCRIPTION (INCLUDE PREReQUISITES):</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fixed Credit Cr. Hrs: 3</td>
<td>1. Pass/Not Pass Only</td>
<td>P: MSIE 360 or permission of instructor. This course studies the applications of classical control systems dealing to the needs of the automotive and motorsports industries.</td>
</tr>
<tr>
<td>2. Variable Credit Range:</td>
<td>2. Satisfactory/Unsatisfactory Only</td>
<td></td>
</tr>
<tr>
<td>Minimum Cr. Hrs (Check One)</td>
<td>3. Repeatable</td>
<td></td>
</tr>
<tr>
<td>Maximum Cr. Hrs</td>
<td>4. Credit by Examination</td>
<td></td>
</tr>
<tr>
<td>Equivalent Credit: Yes</td>
<td>5. Designator Required</td>
<td></td>
</tr>
<tr>
<td>Thesis Credit: Yes</td>
<td>6. Special Fees</td>
<td></td>
</tr>
</tbody>
</table>

Instructional Type | Minutes Per M. Meetings Per Week | Weeks Offered 15 | % of Credits Allocated (Asyn. Or Syn.) | Delivery Method (Internet, Live, Test-Based, Video) | Cross-Listed Courses |
|------------------|---------------------------------|----------------|---------------------------------|---------------------------------|-----------------
| Lecture | |
| Recitation | |
| Presentation | |
| Laboratory | |
| Lab Prep | |
| Studio | |
| Distance | |
| Clinic | |
| Experiential | |
| Research | |
| Ind. Study | |
| Pract/Obser | |

Calumet: Department Head Date
Calumet School Dean Date

Fort Wayne Department Head Date
Fort Wayne School Dean Date

Indianapolis Department Head Date
Indianapolis School Dean Date

North Central Department Head Date
North Central Chancellor Date

West Lafayette Department Head Date
West Lafayette College/School Dean Date
West Lafayette Registrar Date

OFFICE OF THE REGISTRAR
New Course Request

Indiana University

Check Appropriate Boxes: Undergraduate credit [x] Graduate credit [ ] Professional credit [ ]

1. School/Division: School of Engineering & Technology 2. Academic Subject Code: MSTE

3. Course Number: 420 (must be cleared with University Enrollment Services) 4. Instructor: Pete Hytonen

5. Course Title: Automotive Control

Recommended Abbreviation (Optional) (Limited to 32 Characters including spaces)

6. First time this course is to be offered (Semester/Year): Fall 2009

7. Credit Hours: Fixed at [x] 3 or Variable from to

8. Is this course to be graded S-F (only)? Yes [x] No [ ]

9. Is variable rate approval being requested? Yes [x] No [ ]

10. Course description (not to exceed 50 words) for Bulletin publication:

P: MSTE 360 or permission of instructor. This course studies the applications of classical control systems dealing to the needs of the automotive and motorsports industries.

11. Lecture Contact Hours: Fixed at [x] 3 or Variable from to

12. Non-Lecture Contact Hours: Fixed at or Variable from to

13. Estimated enrollment: [x] 25 of which [x] 0 percent are expected to be graduate students.

14. Frequency of scheduling: [x] yearly Will this course be required for majors? [x] yes

15. Justification for new course: Part of the already approved BS in Motorsports Engineering

16. Are the necessary reading materials currently available in the appropriate library? [x] yes

17. Please append a complete outline of the proposed course, and indicate instructor (if known), textbooks, and other materials.

18. If this course overlaps with existing courses, please explain with which courses it overlaps and whether this overlap is necessary, desirable, or unimportant

19. A copy of every new course proposal must be submitted to departments, schools, or divisions in which there may be overlap of the new course with existing courses or areas of strong concern, with instructions that they send comments directly to the originating Curriculum Committee. Please append a list of departments, schools, or divisions thus consulted.

Submitted by:

[Signature]

Dean of Graduate School (where required)

[Signature]

Chancellor/Vice-President

[Signature]

University Enrollment Services

After School/Division approval, forward the copy (without attachments) to University Enrollment Services for initial processing, and the remaining four copies and attachments to the Campus Chancellor or Vice-President.

URS 724

University Enrollment Services-Final-White; Chancellor/Vice-President-Blue; School/Division-Yellow; Department/Division-Black; University Enrollment Services Address-White
MSTE 420: AUTOMOTIVE CONTROL (co-listed with ME 504)
Syllabus

(3 Credit hours)

Instructor: Dr. Sohel Anwar, Assistant Professor, Mechanical Engineering Dept., IUPUI.
E-mail: soanwar@iupui.edu.

Teaching: Mr. Harpreet Banvait, Graduate Student, Electrical and Computer Engineering Dept., IUPUI.
E-mail: hbanvait@iupui.edu.

Lecture Hrs: MW 1:30 PM – 2:45 PM and via Video Stream.
Office Hrs: TR 11:00 AM – 1:00 PM, Phone, and E-mail.


References:

Prereq.: MSTE 360, ECE 382 or ME 482 or equivalent, and any high-level programming languages.

Catalog Description: Basic engine operation; Lambda control, Speed control, Knock control, Fuel injection timing control, Ignition control of SI engines; Engine fault diagnosis; Driveline modeling, Automatic transmission control, Clutch phasing control; Hybrid Electric Vehicle Control; Wheel model, Complete vehicle model; Observers, Friction coefficient estimators, Tire contact patch force estimators; Anti-lock brake control, Traction control, Yaw stability control, Drive-By-Wire systems.

Homework: Homework problems will be assigned approximately once every 2.5 weeks in order for you to understand course materials covered in the lectures. Distance students can submit homework online. Late submissions will not be accepted.

Projects: A final project will be assigned. The project includes a formal report and a presentation. For distance learning students, an audio recorded powerpoint presentation would be sufficient (online submission).

Exams: One in-class midterm and a final exam will be given. The final will be comprehensive with emphasis on the materials which are not covered in the
midterms. For distance students, the exams will be proctored at the respective sites. *No make-up exams are allowed.*

**Academic Misconduct**: *Any cheating in the exams will result in a grade of “F” automatically.* Refer to the section on “Academic Misconduct” outlined in the IUPUI *Code of Student Rights, Responsibilities, and Conduct* for details. [http://www.iupui.edu/code/CSR_0106.pdf](http://www.iupui.edu/code/CSR_0106.pdf)

**Grading:**  Homework 20%, Final Project 25%, Midterm Exam 25%, Final Exam 30%.

**Grading Scale**

<table>
<thead>
<tr>
<th>Letter grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>95-100</td>
</tr>
<tr>
<td>A</td>
<td>90-94.99</td>
</tr>
<tr>
<td>A-</td>
<td>87-89.99</td>
</tr>
<tr>
<td>B+</td>
<td>84-86.99</td>
</tr>
<tr>
<td>B</td>
<td>81-83.99</td>
</tr>
<tr>
<td>B-</td>
<td>78-80.99</td>
</tr>
<tr>
<td>C+</td>
<td>74-77.99</td>
</tr>
<tr>
<td>C</td>
<td>70-73.99</td>
</tr>
<tr>
<td>C-</td>
<td>65-69.99</td>
</tr>
<tr>
<td>F</td>
<td>0-64.99</td>
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</tbody>
</table>

**Americans with Disabilities Act:**
If you need any special accommodations due to a disability, please contact Adaptive Educational Services at (317)-274-3241. The office is located in CA 001E.

**Course Content:**
This course will cover the fundamentals of automotive control systems that are present in today’s cars. It will also briefly review automotive control technologies of the future cars and their impact in our society. Basic engine functions will be illustrated (Four Stroke Cycle, Air-Fuel Ratio, Combustion, and Energy conversion). Various aspects of engine control system such as Speed Control, Knock Control, Fuel Injection timing control, Ignition control of SI engines will be explained. Model based engine fault diagnosis will be introduced. Fundamentals of modeling and control of automatic transmission for automobiles will be covered (automatic gear shifting and clutch phasing control). Hybrid electric vehicle powertrain and its control will be introduced. Vehicle dynamics modeling including Wheel Model will be illustrated. Vehicle parameter and state estimation methods will be briefly explained. Vehicle dynamics control such as Anti-Lock Brake control and Yaw Stability control will also be covered. Advanced topics such as Brake-By-Wire and Steer-By-Wire systems will briefly be described. Modeling of automotive control systems in MATLAB/SIMULINK environment will extensively be used in this course.
Automotive Control Course Outline

<table>
<thead>
<tr>
<th>Lectures</th>
<th>Topics</th>
<th>Week(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>0.5</td>
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<tr>
<td></td>
<td>Why control systems for automobiles? Background on automotive control systems</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SI Engines and Their Working Principle</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>Diesel Engine Modeling</td>
<td>0.5</td>
</tr>
<tr>
<td>4-7</td>
<td>SI Engine Control System</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Lambda Control; Speed Control; Knock Control; Fuel Injection timing control; Ignition control of SI engines</td>
<td></td>
</tr>
<tr>
<td>8-9</td>
<td>Model Based Engine Fault Diagnosis</td>
<td>1.0</td>
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<tr>
<td></td>
<td>OBD II, Fault Modeling, Residual Generation, Fault Detection, Examples</td>
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<tr>
<td>10</td>
<td>Midterm Exam</td>
<td>0.5</td>
</tr>
<tr>
<td>11-14</td>
<td>Driveline Control</td>
<td>2.0</td>
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<tr>
<td></td>
<td>Transmission modeling and control; Transmission control for gear shifting; Clutch phasing control</td>
<td></td>
</tr>
<tr>
<td>15-16</td>
<td>Hybrid Electric Vehicle Powertrain Control</td>
<td>1.0</td>
</tr>
<tr>
<td>17-20</td>
<td>Vehicle Dynamics Modeling</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Wheel Model; Complete Vehicle Model</td>
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</tr>
<tr>
<td>21-24</td>
<td>Vehicle Parameter and State Estimation</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Observers: Velocity Estimation, Vehicle Body Side Slip Angle Estimation; Friction Coefficient estimators, Tire Contact Patch Force estimators, Road Gradient and Mass Moment of Inertia Estimation</td>
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</tr>
<tr>
<td>25-28</td>
<td>Vehicle Dynamics Control</td>
<td>2.0</td>
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<tr>
<td></td>
<td>Anti-Lock Brake control; Traction Control; Yaw Stability control</td>
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</tr>
<tr>
<td>29</td>
<td>Advanced Topics</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Drive-By-Wire: Brake-By-Wire; Steer-By-Wire</td>
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<tr>
<td></td>
<td>Final exam</td>
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Course Objectives:

Upon successful completion of the course, students should be able to:

i. Define current state of automotive control systems and their impact in our society.


iii. Solve various aspects of engine control system: Speed Control; Knock Control; Fuel Injection timing control; Ignition control of SI engines; Engine fault diagnosis.
iv. Perform Automatic Transmission Control: Automatic transmission modeling;
    Automatic Transmission control for gear shifting; Clutch phasing control.
v. Perform vehicle dynamics modeling: Wheel Model; and Vehicle Model.
vi. Calculate various vehicle parameter and perform state estimation methods: Observers;
    Friction Coefficient estimators; Tire Contact Patch Force estimators.
vii. Perform vehicle dynamics control: Anti-Lock Brake control; Yaw Stability control.
viii. Define advanced automotive control techniques: Brake-By-Wire; and Steer-By-Wire.
ix. Define hybrid electric vehicle (HEV) powertrain control system.
x. Perform modeling of automotive control systems in MATLAB/SIMULINK
    environment.
xii. Evaluate and test automotive control system performance using computer-aided tools
     (MATLAB/SIMULINK).