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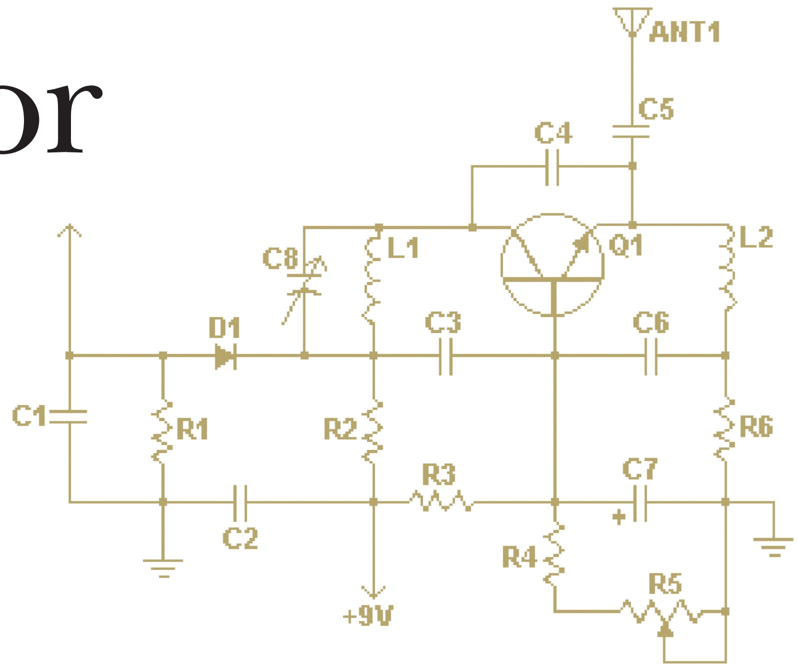
Air Fuel Control for Green Vehicles



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Wednesday April 16, 2008

12:00-1:00 p.m.

Lecture Hall 144

More stringent emissions requirements of automobile engines are placing tremendous performance demands on the engine fueling control strategies. While engine and after-treatment system development are important parts of meeting the regulatory emission requirements, it is generally accepted that control is an essential component of maintaining practically zero engine emissions (PZEV). In fact, the engine fueling control system is the major integrator between the engine and exhaust after-treatment system. Complete integration of the engine and the threeway- catalyst (TWC) could lead to huge improvements in the engine fueling performance. In particular, placing a secondary heated exhaust gas oxygen (HEGO) sensor in or after the TWC and correlating the sensor output to tailpipe emissions is one primary method to enable feedback control of the TWC.

To date, the TWC feedback control strategy has been approached as a problem of the downstream HEGO sensor regulation. Roughly speaking, maintaining the HEGO sensor output as near 0.6 volts as possible correlates to *good* TWC performance. Using a sequential loop closure technique, we first address the A/F ratio controller design and performance (inner loop), and then sequentially and independently design the outer loop controller. The commanded air-fuel (A/F) ratio is the fueling control system input (inner loop) that is trimmed by a feedback controller (outer loop) to maintain the 0.6 volt level in the HEGO sensor. While this control objective is simple, accomplishing it is anything but simple, due to the nature of the TWC dynamics.

In this presentation, we will talk about the overall A/F and TWC feedback control strategy. We will specifically examine the design of the A/F ratio feedback controller and show how the performance of this controller impacts the TWC conversion efficiency. Moreover, we will review the design of the outer loop controller that is suitable for a TWC control and diagnostics utilizing a secondary O_2 feedback (HEGO Sensor). Not only this control strategy approach is recommended in the literature, but also it has been confirmed to work well by experiment.

Dr. Imad Makki is the *Director* of the Foundation Program at WCMC-Q where he is also a *Senior Lecturer* for Physics & Mathematics.

Dr. Makki is a *Technical Expert* (leave of absence) in the area of Powertrian Controls in the Research and Innovation Center at Ford Motor Company.

Dr. Makki received his Ph.D. in 1995 in Electrical Engineering from Wayne State University in Detroit, Michigan. The emphasis of his graduate experience was directed toward robust control system technologies and applied mathematics with applications to automotive systems. His graduate research effort concentrated on creating stability and robustness conditions for nonlinear systems using an $H\infty$ framework.

Over his professional career with Ford Motor Company, Dr. Makki has initiated, funded, and managed multiple research collaboration programs with several universities throughout the United States. Out of these collaboration efforts, he generated several patents, numerous Journal & Conference publications, and received many innovation & research awards including the *Henry Ford Technology Award* – the Company's highest honor for innovative technical contributions by employees.

This lecture is part of ***Electrify Your Education*** *colloquia series sponsored by the Electrical Engineering Program*

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