Proposed Lab Projects

Alternative Energy Vehicle Design and Research Project

Winter Semester 2016

Essential for all projects: Positive attitude, specific skills, appreciation of quality work, time and schedule management to assure task and project completion within deadlines.

1. EFI/Multi-fuel engine conversion

Synopsis:
Conversion of a carbureted automotive engine to electronic fuel injection using aftermarket and student-fabricated components. Wide-range fuel control will allow operation on alcohol fuels as well as gasoline. Engine not yet specified – depends on availability in Engine Laboratory. Engine will preferably be mounted on a dynamometer to allow performance and emissions testing before and after conversion.

Skills required:
Machining skills – TIG welding and use of basic machine tools for modification of intake manifold, fabrication of brackets and fuel plumbing.

Mechanic skills – Understand principles of engine operation. Tear down and reassemble engine.

Fuel handling – Ability to safely handle gasoline and methanol

Basic electrical wiring and interfacing skills. Following direction, will interface sensors, actuators and switches to electronic Control Unit (ECU).

Computer interface - Learn to use PC-based program Tuner Studio to program engine maps and interface settings of ECU.

Estimated budget (purchased components and materials only):
Megasquirt III ECU, fuel injectors, fuel rails, SS EFI fuel pump, air intake adaptor, throttle body assembly, fuel pressure regulator, sensor simulator module, MAP sensor, MAF sensor, idle control actuator, air and fuel filters, fuel lines and fittings, electrical and mechanical hardware, contracted engine mechanical and machine work as required, shipping and taxes. Est: €4000 (Does not include, assumed to be available in engine testing lab).
2. Multi-fuel conversion of motorcycle

Synopsis:

Similar project to (1), except target engine will be a multi-cylinder 4-cycle motorcycle engine retained in the motorcycle chassis, such that result will be a complete street-legal alternative fuel motorcycle. Motorcycle engine will already have an EFI fuel system and be a recent model with a catalytic converter. Project tasks will include replacement of all fuel-wetted components with alcohol-compatible units, including fuel injectors, fuel pump, fuel pressure regulator, filters, fuel lines and fittings. Installation of aftermarket ECU modification unit with O2-sensing autotuning (e.g., Power Commander PC V), and student-fabricated components. Wide-range fuel control will allow operation on alcohol fuels as well as gasoline. Engine motorcycle not yet specified – depends on availability. Student-owned vehicle may be used. Reference project: https://courseware.ee.calpoly.edu/~amaccarl/MyMethanolMotorcycle/

Skills required:

Machining skills – Fabrication of brackets and fuel plumbing.

Mechanic skills – Understand principles of engine operation. Tear down and reassemble engine.

Fuel handling – Ability to safely handle gasoline and methanol

Basic electrical wiring and interfacing skills. Following direction, will interface sensors, actuators and switches to electronic Control Unit (ECU).

Computer interface - Learn to use PC-based program Tuner Studio to program engine maps and interface settings of ECU.

Estimated budget (purchased components and materials only):

ECU-modifier equivalent to Power Commander PC-V with AutoTune module and display unit. SS EFI fuel pump, fuel pressure regulator, sensor simulator module, MAP sensor, idle control actuator, air and fuel filters, fuel tank internal coating for alcohol compatibility, fuel lines and fittings, electrical and mechanical hardware, methanol fuel 216L drum, fuel dispensing equipment, contracted engine mechanical and machine work as required, shipping and taxes. Est: €4000 (does not include vehicle).
3. DME diesel engine conversion

Synopsis:

Dimethyl Ether (DME) is a renewable clean-burning potential replacement for diesel fuel that can be produced from biomass. However, the fuel system of a diesel engine must be radically modified to accommodate this fuel, which has very challenging delivery and storage characteristics. We will modify a small single cylinder diesel engine to operate on DME. Requires radical modification of a simple fuel injection pump including replacement and fabrication of some components. We will use a low-cost 600CC single cylinder diesel generator engine, and use the generator as a variable load for performance testing before and after the conversion.

Skills required:

Machining: Precision machining of hardened steel.

Mechanical: installation of high pressure fuel pump, modified LPG tank and nitrogen purge tank. Plumbing of low and high pressure fuel lines. Fabrication of brackets

Electrical: Basic automotive electrical wiring. Connectors, actuators, sensors, switches.

Estimated budget (purchased components and materials only):

Small diesel generator equivalent to [http://www.ebay.com/itm/ETQ-Eastern-Tool-Equipment-4000W-Air-cooled-7HP-Diesel-Generator-DG4LE-/252470142571?hash=item3ac864a66b:g:F0sAAOSwP0RXh-0z](http://www.ebay.com/itm/ETQ-Eastern-Tool-Equipment-4000W-Air-cooled-7HP-Diesel-Generator-DG4LE-/252470142571?hash=item3ac864a66b:g:F0sAAOSwP0RXh-0z) with shipping and taxes €1000.

Extra injection pump assembly 7012000A [http://dieselgeneratorsonline.net/PartStore.aspx](http://dieselgeneratorsonline.net/PartStore.aspx) €250

20L aluminum LPG tank with mounting brackets and fittings €600.

Contracted precision machine work (est) €1000.

Air and fuel filters, fuel lines and fittings, fuel pressure regulator, electrical and mechanical hardware, shipping and taxes. Est: 1000 €.

20 kg, dimethyl ether including 6 month tank demurrage and required fuel handling provisions €1000.

Total (est): €4850
4. Laboratory scale Biomass-to-Methanol production apparatus

Synopsis:

Methanol is a well-established renewable fuel that can be made from almost any hydrocarbon feedstock or from organic biomass. While it universally produced from natural gas at this time, long-term interest in methanol is focused on its neutral carbon balance if made from renewable biomass. Commercial production from biomass is difficult and not currently cost-effective. Reference: [http://www.biofuelstp.eu/factsheets/methanol-fact-sheet.html](http://www.biofuelstp.eu/factsheets/methanol-fact-sheet.html) and [https://publications.lib.chalmers.se/records/fulltext/218484/local_218484.pdf](https://publications.lib.chalmers.se/records/fulltext/218484/local_218484.pdf)

But for demonstration purposes, it is possible to construct a laboratory scale apparatus that can convert a small batch of cellulosic biomass such as wood chips into fuel quality-methanol via gasification, reformation and distillation. Hobbyists and local producers in rural China have employed apparatuses as simple as [http://www.instructables.com/id/Make-Wood-Gas-Wood-Alcohol/](http://www.instructables.com/id/Make-Wood-Gas-Wood-Alcohol/) reminiscent of the crude methods used to make methanol (aka wood alcohol) early as the late 19th century.

This project will attempt to design, construct and demonstrate a laboratory apparatus for the production of very small quantities of crude-but-combustible methanol from biomass in three steps: biomass gasification, catalytic reformation and final distillation to remove water.

Skills required:

Basic laboratory skills for handling flammable liquids.

Mechanical: Plumbing of moderate pressure high-temperature tubing and hoses. Fabrication of brackets

Electrical: Connection of temperature and pressure monitoring instrumentation.

Estimated budget (purchased components and materials only):

Purchased home-scale biomass gasifier kit, e.g., [http://www.leafgenerator.com/](http://www.leafgenerator.com/) €4500

Fabrication of catalytic reformation reactor: €3000 (broad estimate)

Tankage, pressure regulation, piping and tubing, filters, mounting brackets and fittings €500.

Temperature and pressure monitoring sensors for interface to data acquisition system. €500.

Electrical and mechanical hardware, shipping and taxes. Est: €500.

Additional fire safety equipment – protective clothing and dry-chem fire extinguisher. €500.

Total (est): €9500.
Assessment and basis of course grade

Weekly design review presentations and printed status reports (team). Must include Gantt chart, technical graphics, budget status, description of completed tasks, documentary photographs, data collected, description of tasks remaining to be completed. 40%

Participation in weekly design review assessments (individual) 5%

Final project demonstration. Physical exhibition of project in operation. Assessed based upon degree of completion of the project, quality of execution and performance results. 25%

Final PowerPoint presentation describing all project work, timeline, budget, design details and collected data. Demonstration will serve basis of assessment degree of project completion. Grade is based 15%

Final project reports (individual). Describes specifically the work completed by the individual team member as their contribution to the team results. 15%