THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
FINAL EXAMINATION – 2009/2010

MEX 6331– AUTOMOBILE ENGINEERING

DATE	**: 24th March 2010**
TIME	**: 1400 -1700 HRS**
DURATION	**: THREE HOURS**

INSTRUCTIONS :
This question paper consists of two parts. Part A consists of two (02) questions and Part B consists of six (06) questions. You are required to answer **only five (05)** questions selecting at least one (01) question from Part A. All questions carry equal marks.

PART A

QUESTION 01

Starting from first principles derive an expression for the air standard efficiency of the Otto cycle in terms of compression ratio.

A four stroke, spark ignition engine was tested on a rope brake dynamometer and the following results were obtained.

<u>Dynamometer</u>

Effective diameter of the drum	- 600 mm
Load applied	- 490 N
Spring balance reading	- 64 N

<u>Engine</u>

Total swept volume	- 2 liters
Speed of the engine	- 2,400 rev/min
Air fuel ratio	- 15:1
Specific fuel consumption	- 0.255 kg/kW-h
Calorific value of fuel	- 44 MJ/kg
Temperature of air inhaled	- 30°C
Pressure of air inhaled	- 103 kPa
Gas constant for air	- 0.287 kJ/kg K

Determine:

(i) Brake power
(ii) Brake mean effective pressure
(iii) Brake thermal efficiency
(iv) Volumetric efficiency of the engine

Question 2

a) Define the following
   i. Swept volume
   ii. Clearance volume
   iii. Compression ratio
   iv. Brake power

b) Following information is given with respect to a four cylinder four stroke spark ignition engine

Cylinder bore diameter	- 140 mm
Piston stroke length	- 150 mm
Clearance volume	- 0.4 litres
Calorific value of the fuel used	- 45 MJ/kg
Brake specific fuel consumption	- 0.25 kg/kW
Mechanical efficiency	- 80 %
Ratio of specific heats for the air fuel mixture (γ)	- 1.4

Calculate:
   (i) Compression ratio.
   (ii) Ideal air standard cycle efficiency.
   (iii) Indicated thermal efficiency.

Part B

Question 3

a) Ethanol is used as an alternative fuel in many countries. Briefly comment on the availability of raw material in Sri Lanka for bio ethanol production.

b) "Biodiesel can be used as a fuel additive to reduce Particulate matter." Substantiate the above statement referring to the figure Q3.

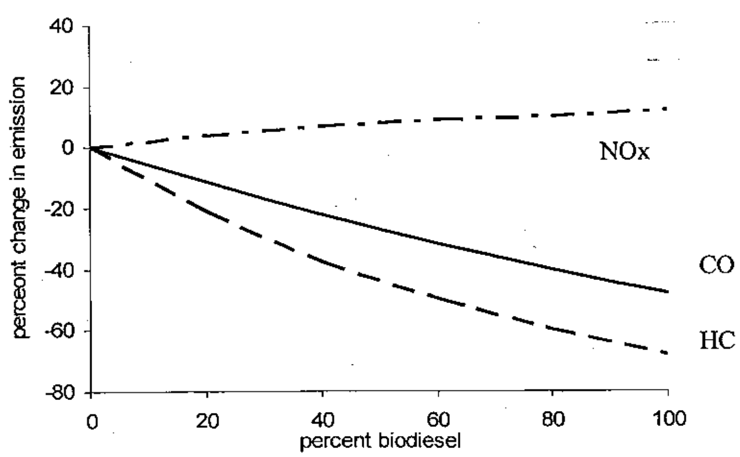

Fig.Q3

c) Briefly explain the construction of a parallel hybrid power train design, using a rough sketch.

d) Briefly explain the operating principle of a proton exchange membrane fuel cell using a rough sketch.

Question 4

a) Draw a schematic diagram of a modern electronically controlled fuel injection and ignition system and explain its operating principle.

b) In an electronically controlled fuel injection system of a four stroke engine, the mass of fuel delivered per cylinder per cycle is determined by the equation.

$$F = \frac{MAF}{r(N/2)\left(A/F\right)_d} \qquad \text{------(1)}$$

Where

MAF	-	Mass Air Flow rate in kg/sec
r	-	engine speed in rev/sec
N	-	number of cylinders
$(A/F)_d$	-	desired air fuel ratio

As the actual injected fuel quantity is controlled by the pulse width of the injector operating signal, the pulse width duration is calculated by $T = \frac{F}{R_f}$,

where, R_f is the fuel injector delivery rate. Further, the desired $(A/F)_d$ ratio is adjusted by the signal given by the lambda sensor (lambda closed loop control)

Referring to the equation (1), explain how the pulse width duration is accurately calculated if the lambda closed loop control is malfunctioning (open loop).

c) Explain NO_x emissions control strategies used in Compression Ignition engines.

Question 5

Briefly explain the following

a) Antilock braking system.

b) Traction control

c) Stability control

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Question 6

Starting from the steady flow energy equation and neglecting compressibility effects, show that the air fuel ratio (λ) of the mixture delivered by a simple carburetor is given by

$$\lambda = \left(\frac{C_a}{C_f}\right)\left(\frac{d_a}{d_f}\right)^2\left(\frac{\rho_a}{\rho_f}\right)^{1/2}$$

where suffix a refers to air, f refers to fuel and symbols C, d & ρ to coefficient of discharge, diameter and density respectively. Assume that the fuel level in the fuel jet is the same as that of the reservoir.

A simple carburetor has the following parameters.

$C_a = 0.8$ $\quad$ $C_f = 0.9$,
$d_a = 18.0$ mm $\quad$ $d_f = 0.90$ mm
$\rho_a = 1.18$ kg/m^3 $\quad$ $\rho_f = 840$ kg/m^3

This carburetor is fitted to a four stroke spark ignition engine having a total swept volume of 1.5 liters. The fuel consumption of the engine was observed to be 9.2 kg/hr at a speed of 3,000 rev/min. Determine the volumetric efficiency of the engine.

Question 7

(a) Figure Q7 shows the arrangement of two cylinder four stroke engine with both pistons on one side and having opposite movements.

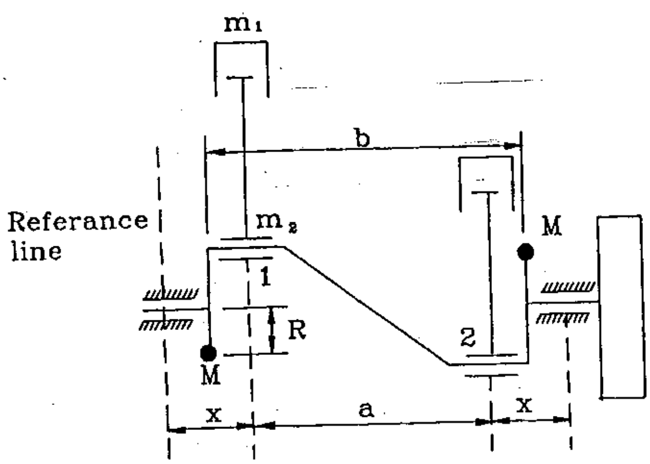

Figure Q7

Show the status of balance/ unbalance of the following parameters.

i. Primary forces (F_p),
ii. Primary couples (M_p),
iii. Secondary forces (F_s),
iv. Secondary couples (M_s),
v. Forces due to revolving masses (F_g),
vi. Couples due to revolving masses (M_R).

(b) Briefly explain the function of following additives in lubricating oils.

i. Detergent Additives,
ii. Dispersant Additives,
iii. Anti Wear Additives,
iv. Anti Rust Additives,
v. Oxidation Inhibitors.

Question 8

A four cylinder gasoline engine has a compression ratio of 9 and a total swept volume of 2.0 litres. The indicated thermal efficiency is 60% of the corresponding ideal air standard Otto cycle efficiency. At rated speed of 3000 rev/min, the mechanical efficiency and the volumetric efficiency are 80% and 75% respectively. The air fuel ratio by mass is 14:1 and the calorific value of the fuel is 45 MJ/kg. Air is induced to the engine at a pressure of 103 kPa and a temperature of 30 °C.

Calculate the power output of the engine.
Take $\gamma = 1.4$ and the gas constant $R = 0.287$ kJ/kgK.

END.