THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
FINAL EXAMINATION - 2005

MEX 6331/MEU4302 – AUTOMOBILE ENGINEERING

DATE : 7TH MAY 2006
TIME : 1330 HRS - 1630 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.

Dynamometer

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

Engine

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 02

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.

$C_a = 0.85$ $\quad C_f = 0.95$,
$d_a = 20.0$ mm $\quad d_f = 0.95$ 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 1.6 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.

PART B

QUESTION 03

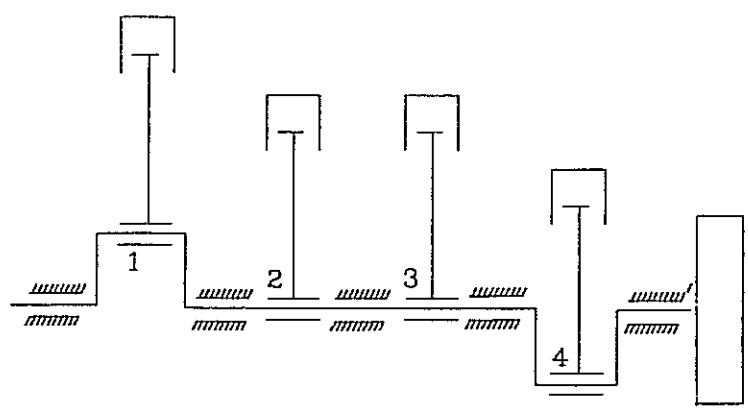


Fig. Q3

Fig. Q3 shows the configuration of a four cylinder engine working on the two stroke cycle with a firing order 1-3-4-2. Investigate the balancing of the engine for

(i) Primary forces and moments
(ii) Secondary forces and moments.

Using the information given below calculate the magnitude and direction of any unbalanced forces and moments.

Piston stroke length	- 100 mm
Mass of the reciprocating parts of each cylinder	- 2 kg
Speed of the engine	- 3,600 rev/min
Distance between the center lines of adjacent cylinders	- 200 mm

QUESTION 04

The total resistance to the motion of a vehicle consists of three components. What are these components? Explain briefly.

The following data are available in respect of a vehicle and its motion.

Mass of the vehicle	- 2,500 kg
Coefficient of rolling resistance	- 0.025
Aerodynamic drag coefficient	- 0.3
Total projected frontal area	- 4 m^2
Velocity of head wind	- 24 km/h
Transmission efficiency in the top gear	- 90%
Transmission efficiency in the second gear	- 85%
Gear reduction in the final drive	- 4
Effective diameter of the road wheel	- 600 mm
Density of air	- 1.18 kg/m^3

Determine the maximum power of the engine if the maximum speed on a level track in the top gear is 100 km/h and the speed of the engine at which this power is produced.

Show that the maximum speed of the vehicle on a road having a gradient of 5^o in the second gear is between 55 km/h and 60 km/h.

QUESTION 05

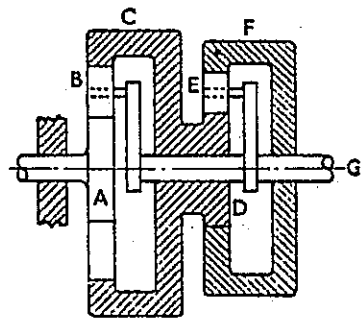


Fig. Q5

In the compound epicyclic gear shown in Fig. Q5, C & D form a compound wheel, which rotates freely on shaft G. The planet wheels B & E rotate on pins fixed in arms attached to shaft G. C & F have internal teeth and the others have external teeth. Number of teeth on different gears are: A – 40, B – 30, D – 50, E – 20. If A rotates at 700 rev/min and wheel F is fixed, find the speed of shaft G.

If C is fixed instead of F, what is the speed ratio between A and G?

QUESTION 06

A vehicle has the following parameters.

Wheel base - b
Height of center of gravity above the ground - h
Location of center of gravity behind the front axle - a

This vehicle moves up an incline having a gradient θ° to the horizontal. If brakes are applied on all four wheels and limiting friction conditions are reached at all four wheels, show that the ratio (α) of braking forces on front and rear wheels is given by

$$\alpha = \frac{b - a + \mu h}{a - \mu h}$$

where μ is the coefficient of friction between the wheels and the road.

If the brakes are applied when the vehicle is moving with a speed V, show that the distance s traveled by the vehicle before it comes to rest is given by

$$s = \frac{V^2}{2g \sin\theta (1 + \mu \cot\theta)}$$

Also show that the ratio (β) of the load transferred from the rear axle to the front axle due to braking and the weight of the vehicle is given by

$$\beta = \frac{h}{b}(\mu \cos\theta + \sin\theta)$$

QUESTION 07

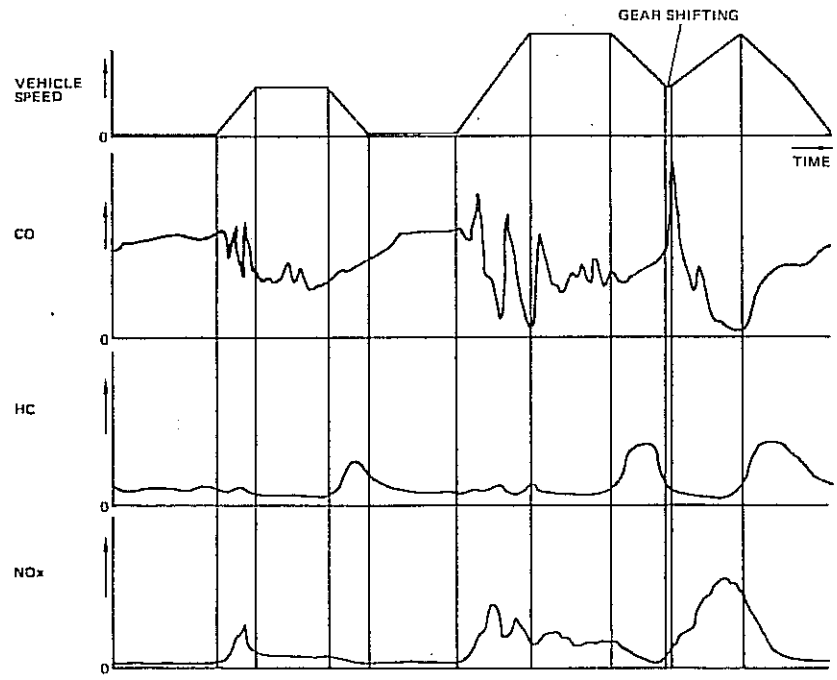
(i) A vehicle has a wheel base of 2.8 m and the distance between pivot centers is 1.1 m. The wheel track at the front and the rear is 1.22 m. If the maximum angle through which the inner front wheel can be turned (to lock position) is 40°, determine the turning radius of the vehicle.

(ii) Explain briefly the requirements of a steering system of a vehicle.

QUESTION 08

(i) Explain the reasons for the abnormal tyre wear of a motor vehicle.

(ii)



Relationship Between a Typical Driving Pattern and Exhaust Gas

Fig. Q8

Fig. Q8 shows the variation of concentration of CO, HC, NO_X in the exhaust gas of a vehicle not equipped with emission control systems. What conclusions can be drawn from these graphs?

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