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

MEX 6332/MED 2207 – VEHICLE DYNAMICS AND DESIGN OF AUTOMOTIVE COMPONENTS

PAPER I	-	VEHICLE DYNAMICS COMPONENT
DATE	:	30TH MARCH 2006
TIME	:	1330 HRS - 1530 HRS
DURATION	:	TWO HOURS

ANSWER ANY FIVE (05) QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS.

QUESTION 01

A rear wheel driven vehicle has a static load distribution between the front axle and the rear axle in the ratio of 9:11. The height of the centre of gravity above the ground is one-fifth of the wheel base. Calculate the greatest acceleration obtainable without skidding the rear wheels on a level track when the coefficient of friction between the tyres and the ground is 0.45.

What is the steepest gradient that the vehicle would climb, if the coefficient of friction is 0.5?

QUESTION 02

A motor vehicle of mass of 1,500 kg has an engine which develops 60 kW when the vehicle is travelling on a level track at a steady speed of 120 km/h in top gear. Under these conditions the engine speed is 4200 rev/min and the transmission efficiency is 90%. The resistance (R) to the motion of the vehicle, $R = \alpha + 0.3V^{1.5}$ (N), where V is the speed of the vehicle in km/h and α is a constant. Calculate the value of the constant α. Also determine the gear ratio of the final drive if the wheel radius is 300 mm.

The vehicle now climbs a gradient of inclination 10°, at a uniform speed of 50 km/h in the second gear with an overall transmission efficiency of 88%. Determine the engine power required to climb the gradient.

QUESTION 03

A motor vehicle of mass 1,400 kg has a wheel base of 2.6 m. Its centre of gravity is located at a point 1.3 m behind the front axle and 0.8 m above the ground level. The vehicle is fitted with brakes on all four wheels and the coefficient of adhesion between tyres and road is 0.55. The vehicle moves up an incline of gradient $\sin^{-1}(0.15)$. If only the rear brakes are applied, determine:

(i) Load distribution between the front and rear wheels, and
(ii) Distance travelled by the vehicle before it comes to rest from a speed of 50 km/h.

QUESTION 04

(i) What are the factors that influence the coefficient of drag? Explain briefly.

(ii) Following information are given with respect to a passenger vehicle.

Frontal projected area of the vehicle	-	2.92 m^2
Aerodynamic drag coefficient	-	0.42
Speed of the vehicle	-	90 km/h
Ambient pressure	-	1.03 bar
Ambient temperature	-	30^0C

Calculate the aerodynamic drag force if the vehicle is driving into a head wind of speed 30 km/h. Take R = 0.287 kJ/kg K for air.

If the rolling resistance of the vehicle is at a constant value of 345 N, determine the additional power required to maintain the same vehicle speed in a head wind of speed 40 km/h.

QUESTION 05

The following information are available in respect of a motor vehicle.

Wheel base	- 2950 mm
Static axle load distribution ; Front axle : Rear axle	- 11 : 9
Stiffness of each coil spring fitted to either side of front suspension	- 1.4 x 10^5 N/m
Stiffness of each leaf spring assembly fitted to either side of rear suspension	- 1.1x 10^5 N/m
Stiffness of each of the four tyre springs	- 1.2 x 10^6 N/m

If the vehicle moves over a hump inadvertently, determine the position of its elasticity centre. State any assumptions you make.

QUESTION 06

(i) Draw a schematic diagram of a "quarter car model" to represent the suspension system of a vehicle. Indicate the sprung mass, unsprung mass, suspension elements, etc. clearly in the diagram.

Write the differential equations governing the motions of the sprung mass and unsprung mass.

(ii) The following particulars are available in respect of a "quarter car model" of a suspension system of a vehicle.

Stiffness of the suspension spring	- 180 N/mm
Stiffness of the tyre	- 1,650 N/mm
Weight of the sprung mass	- 2,750 N
Damping coefficient of suspension elements	- 1,825 Ns/m

Determine the natural frequency and the damped natural frequency of the system.

QUESTION 07

(i) What are the advantages of a Rubber spring suspension system? Explain.

(ii) The static deflection imposed on flexible rubber mount springing by the mass of an engine is 2 mm. This engine oscillates vertically with a frequency of 750 vibrations per minute. Determine the ratio of the disturbing frequency and the natural frequency. Is this ratio close to the resonance condition and if so, what remedial action you would take.

QUESTION 08

(i) "Car safety may be broadly divided into two categories". What are these categories? Explain.

(ii) What is meant by "Cross country ability of a vehicle"? Explain.

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