THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF TECHNOLOGY - LEVEL 06
FINAL EXAMINATION – 2009/2010
MEX 6332 : VEHICLE DYNAMICS AND DESIGN OF AUTOMOTIVE COMPONENTS
DATE : 01st April 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

(a) Derive an equation to express the maximum torque transmitted by a multi-plate clutch if;
r_1 - internal radius of the effective area
r_2 - external radius of the effective area
μ - the limiting coefficient of friction
P - axial spring pressre
Assume that the pressure is uniformly distributed over the contact area.

(b) The following information is available for a single plate clutch of an automobile.

The clutch has effective clutch lining on both sides of the plate disc.

Maximum possible torque developed by the engine	- 46 Nm
Coefficient of friction of the clutch lining	- 0.25
Maximum axial pressure developed by the clutch	- 0.9×10^5 N/m^2
Ratio r_2: r_1	- 1.4

Design a clutch plate to suit the above conditions.

(c) If an engine drives a load through the above clutch unit, determine the time required for the rotating components of the load to reach 1500 rev/min from standstill when it transmits the maximum torque. Assume the equivalent moment of inertia of rotating components of the load to be 1.9 kgm^2.

Question 02

a) Derive an expression for the stopping distance for a vehicle in terms of coefficient of friction between the road wheel and the road and speed of the vehicle, if brakes are applied on all four wheels.

b) If a car is traveling at 64 km/h, determine the required coefficient of friction between road surface and the tyre if the vehicle is to be stopped within 27 m distance from the instant the brakes are applied.

Part B

Question 03

a) The variation of rolling resistance with linear velocity for identical cross ply and radial ply tyres is shown in the Fig.Q3. Explain why the coefficient of rolling resistance increases with velocity at a higher rate in a cross ply tyre, compared to the radial ply tyre.

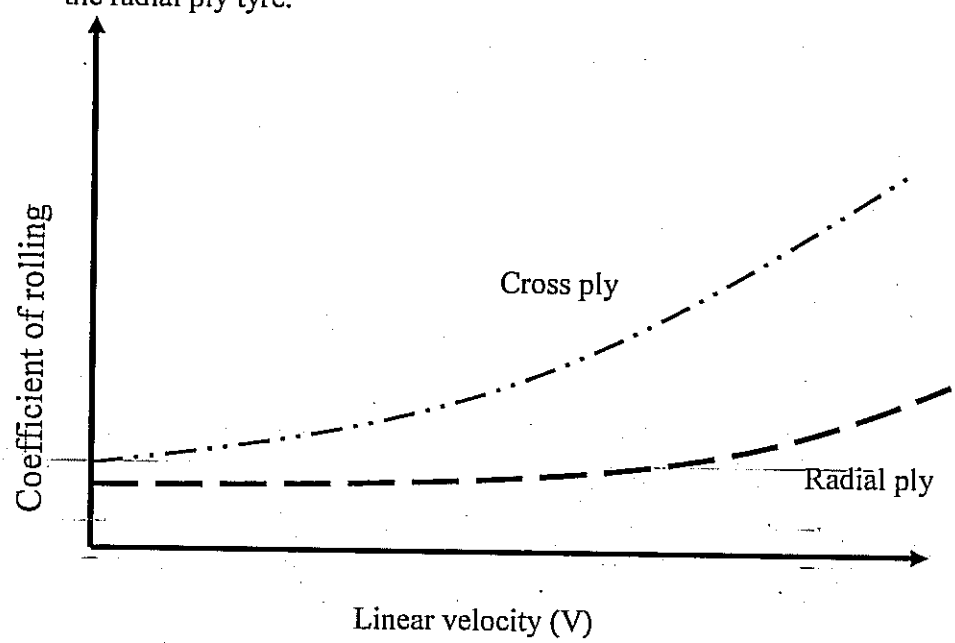


Fig. Q3

b) With aid of a sketch, explain the variation of coefficient of friction for a locked wheel and an un locked wheel with vehicle speed.

c) With aid of a sketch explain what is slip angle.

d) Explain what is cornering stiffness.

e) Explain what is pneumatic trail.

f) Explain what is longitudinal slip.

Question 04

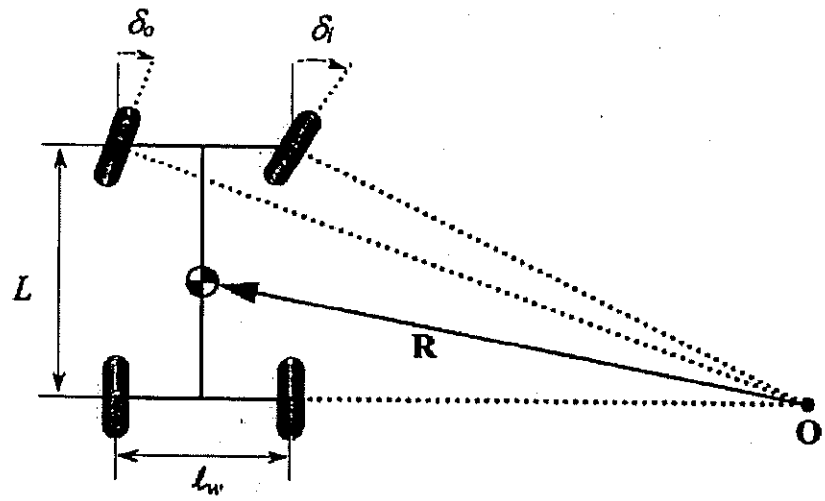


Fig. Q 4

For the steering geometry shown in Fig. Q4, show that the average steering angle δ is given by $\delta = \frac{\delta_o + \delta_i}{2} \cong \frac{L}{R}$

Question 05

Specifications for a electric vehicle is given in below. Select a suitable motor from table 5 to suit the given specifications. (Take the weight of a 12V battery as 18 kg and neglect aerodynamic resistance).

Length	3480 mm
Width	1482 mm
Ground clearance	140 mm
Wheel track	1316 mm
Wheel base at full load	2270 mm
Turning circle	7000 mm
Radius of the road wheel	115 mm
Payload	Weight of batteries plus 280 kg
Drive Train:	Electric motor
Max. speed	20 km/hr
Max. grade	7%

Item	Power kW	Voltage	Mass
MT2117	17.5	120V	15kg
MT2112	4.15	36V	12kg
MT2120	19	144V	15kg
MT2114	13	120V	15kg
MT2115	10	144V	15kg
MT2110	2	36V	12kg
MT2116	17.5	120V	15kg
MT2111	3.8	48V	12kg
MT2113	8	96 V	15kg

Table 5

Question 06

(a) From first principles derive mathematical expressions to determine the following items of a disc brake unit:

(i) Frictional braking torque acting on the pad of disc brake system.

(ii) Work done per minute by this torque.

(iii) Amount of heat generated per second when brakes are applied.

(b) Following data of a disc brake system of an automobile are available.

Effective radius at which hydraulic force is applied - 130 mm
Contact area of each pad - 0.002 m^2
Coefficient of friction between pads and disc - 0.37
Frictional braking torque to be exerted - 135 Nm

(i) Calculate the hydraulic pressure developed inside the wheel cylinder during braking.

(ii) If the disc speed reduces uniformly from 15 rev/sec to 7.5 rev/sec while braking, determine the power absorbed by the brakes of an automobile fitted with two such brake assemblies.

(iii) Calculate the total heat generated when brakes are applied.

Question 07

a) Determine the minimum stable height to the location of the center of gravity from the ground level to satisfy the following conditions when the vehicle is running on a banked track.

Mass of the vehicle	- 4300 kg
Coefficient of friction between the road and wheel	- 0.55
Radius of the curvature of the track	- 20 m
Inclination of the track	- 15^0
Length of the wheel track	- 1.3 m
Maximum linear velocity	- 60 km/h

Question 08

The following informations are available with regard to a gasoline engine running at 1800 rev/min.

- Crank radius - 50 mm
- Length of the connecting rod - 200 mm
- Diameter of the piston - 80 mm
- Mass of the reciprocating parts - 1 kg
- Gas pressure on the piston during power stroke when it is moved 10 mm from the top dead centre - 0.7 N/mm^2

Determine:

(i) Net load on the gudgeon pin,
(ii) Thrust in the connecting rod,
(iii) Reaction between the piston and cylinder, and
(iv) The engine speed at which the above values become zero.

END.

ALL RIGHTS RESERVED.