THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF TECHNOLOGY - LEVEL 06
FINAL EXAMINATION – 2008/2009
MEX 6332 : VEHICLE DYNAMICS AND DESIGN OF AUTOMOTIVE COMPONENTS
DATE : 8th April 2009
TIME : 0930 hrs to 1230 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) In a design process of a vehicle, you are required to 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

b) The contact behavior of the tyre and road can be explained as a combination of adhesion and hysteresis. Explain the effect of adhesion and hysteresis of a tyre on the coefficient of rolling resistance.

c) Using a neat sketch, show the variation of the coefficient of rolling resistance with road speed for biasply and radial ply tyres on a wet ground.

Question 02

a) Derive an equation to express the inertia force produced by reciprocating parts of a crank mechanism, in terms of crank radius (r) , connecting rod length (l)and constant angular velocity of the crank shaft (ω), when the crank makes an angle θ measured anti clockwise from the center line for a displacement x of the piston travel from TDC.

b) A vertical petrol engine with cylinder bore diameter of 90 mm and 110 mm stroke has a connecting rod 250 mm long. The mass of the piston is 900 g. The engine is running at a speed of 2000 rev/min. The gas pressure is 750 kN/m^2 on the expansion stroke when the crank angle is 200 from top dead centre,

Determine:

1. Net force on the piston,
2. Resultant load on the gudgeon pin,
3. Thrust on the cylinder walls,
4. Speed above which, other things remaining same, the gudgeon pin load would be reversed in direction.

Part B

Question 03

(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 pressure
Assume that the pressure is uniformly distributed over the contact area.

(b) The following information are 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	- 35 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 04

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 stropped within 27 m distance from the instant the brakes are applied

Question 05

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

(i) Frictional braking torque acting on the pad.
(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	- 0.3
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 06

The turning moment curve for an engine is represented by the equation, $T = (18000 - 8500 \sin 2\theta - 5000 \cos 2\theta)$ Nm, where θ is the angle moved by the crank from bottom dead centre. If the mean speed of the engine is 200 rev/min and fluctuation of speed does not exceed 1% of mean speed. find:

1. Power developed by the engine

2. Moment of inertia of flywheel

3. Angular acceleration of the flywheel when the crank has turned through 45° from bottom dead centre.

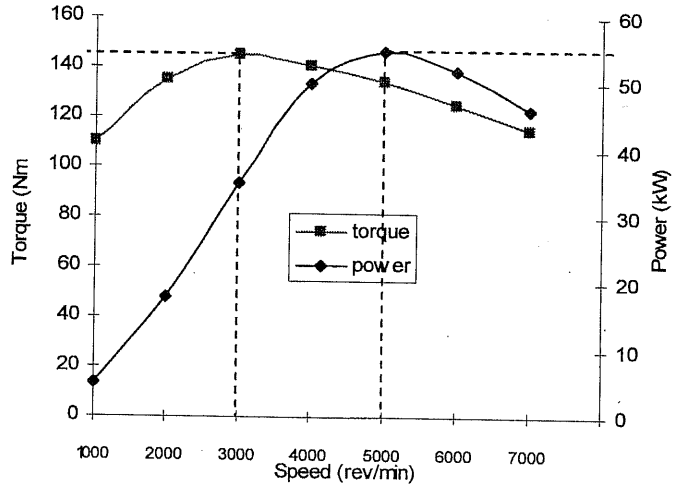
(assume that the resisting torque is constant)

Question 07

An engine of a vehicle was tested on a chassis dynamometer and the following performance curve was generated. The testing revealed that the rolling resistance and the aerodynamic drag resistance is given by$155+0.35$ V and 0.11 V^2 respectively. The total mass of the car is 1500 kg.

(a) if the vehicle was tested in the top gear and the maximum speed at 5000 rev/min, the speed of the vehicle is 142 km/h

(i) Determine the overall transmission efficiency and the overall gear ratio
(ii) Acceleration at maximum engine torque condition.



Question 08

Experiments with automobiles have indicated that under some conditions very fast steering ratios can lead to more accurate steering than conventional steering ratios. This leads to the possibility that active steering systems may not only improve the stability of a vehicle but may also be adapted to provide better controllability for particular maneuvers. A simple example of this idea that is now commercially in several forms is speed-dependent steering. At slow speed, the steering is made more responsive so less motion of the steering wheel is required for parking but at high speeds the steering ratio is made ''slower'' so that the driver does not feel that the car reacts too violently.

Steering the rear wheels in the opposite direction to the front wheels at low speeds and not steering them at high speeds can accomplish a similar effect. The main reason for doing this is usually to reduce the minimum turning circle but in effect the steering ratio is also changed. A more direct way to change the ratio is to steer the front wheels either ''by wire'' using an actuator alone or by using a deferential in the steering column to allow the road wheels to be turned by a combination of driver input and actuator input.

(a) The law in some countries requires that there must be a direct mechanical connection between the driver's steering wheel and the road wheels. Suggest a method that has been proposed in the above passage to address this problem and still have an active steering system.
(b) Draw a schematic diagram for the above method that you are proposing.
(c) Explain whether the relationship between the steering wheel angle and the angle of the road wheels is fixed In an active steering system

END.