THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF TECHNOLOGY - LEVEL 06
FINAL EXAMINATION – 2007
MEX6332 : VEHICLE DYNAMICS AND DESIGN OF AUTOMOTIVE COMPONENTS
PAPER II : DESIGN COMPONENT
DATE : 12 MAY 2008 (Monday)
TIME : 0930 - 1130
DURATION : TWO HOURS

INSTRUCTIONS : This question paper consists of six (06) questions. You are required to answer any four questions. All questions carry equal marks.

Question 01

(i) An **electric vehicle conversion** is the modification of a conventional internal combustion engine (IC) driven vehicle to battery electric propulsion. Draw a schematic diagram for a proposed electric vehicle conversion consisting of a battery pack, electric motor, voltage regulator and suitable indicators for the dash board.

(ii) Explain selection criteria for major components for the conversion.

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) Following information are available for a single cylinder two stroke internal combustion engine and its crank mechanism.

Crank radius	- 140 mm
Connecting rod length	- 510 mm
Effective mass of the reciprocating parts	- 75 kg
Speed of the engine	- 2600 rev/min
Bore diameter of the cylinder	- 150 mm
Law according to which the gas expands	- $PV^{1.4}=30$
(where, P - absolute gas pressure in N/m^2, V - volume occupied by the gas in m^3)	
Clearance volume	- 0.5×10^{-3} m^3

For the crank position $\theta = 45^0$, Determine:

(i) Side pressure on the cylinder walls for the given crank position.
(ii) Turning moment of the crankshaft for the same crank position.

(Assume no offset between the center line of the cylinder and the axis of rotation of the crank shaft).

Question 03

(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	- 0.37
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 04.

(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 x 10^5 N/m^2
Ratio r_2: r_1	- 1.4

Design a clutch plate to suit the above conditions.

Question 05.

Coil suspension spring of a vehicle has 10 effective coils with mean coil diameter 130mm. It is made out of wires of diameter 15 mm. The spring is designed to carry a maximum static load of 3530 N. Calculate the shear stress and the deflection under the above loading condition.

If a maximum shear stress of 6370 N/m^2 is allowable for the spring material, what is the possible clearance in the spring ?

Take the value for modulus of rigidity as $7.35 \times 10^{10} N/m^2$

Question 06

Design a suitable propeller shaft assuming that the shaft is subjected to torsion only, for a vehicle with following specifications.

Maximum torque developed by the engine	- 210 Nm
Gear ratio at the first gear	- 2.5
Gear ratio at the reverse gear	- 2.8
Final drive ratio	- 5
Effective road wheel diameter	- 0.8 m
Coefficient of friction between tyre and road	- 0.75
Permissible shear stress of the shaft material	- $3234 \times 10^5 N/m^2$

(Assume that the shaft is of constant cross sections)

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