The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Diploma in Technology / Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX6232 Vehicle Dynamics**
Academic Year	:	2014/15
Date	:	13th September 2015
Time	:	0930 hrs. – 1230 hrs.
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of two parts, A and B. 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.
3. All questions carry equal marks.

PART A

QUESTION 01

A sports car has a mass of 1500kg and a center of mass at G located 1.25 m behind the front wheel and 0.35 m above the ground. The wheel base is 2.25 m. the coefficient of adhesion between the road and tyre is 0.2.

(i) Determine the shortest time it takes for it to reach a speed of 80 km/h, starting from rest, if the engine drives only the rear wheels (whereas the front wheels are free rolling).

(ii) If driving power could be supplied to all four wheels, what would be the shortest time for the car to reach a speed of 80 km/h

You may neglect the mass of the wheels.

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 is 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	- $PV^{1.4}=30$
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).

PART B

QUESTION 03

The car shown in Fig. Q3, having a mass of 1400 kg and mass center at G_c , pulls a loaded trailer having a mass of 800 kg and mass center at G_t. Coefficient of adhesion between the road and the car is 0.4 and the hitch at A is a pin or ball-and-socket joint. The wheels at B and D are free to roll (Neglect the mass of wheels and the mass of the driver).

If the driver applies the car's rear brakes C and causes the car to skid. Determine,

(i) Normal reactions on the car's front wheels.
(ii) Normal reactions on the car's rear wheels.
(iii) Normal reactions on the trailer's wheels.

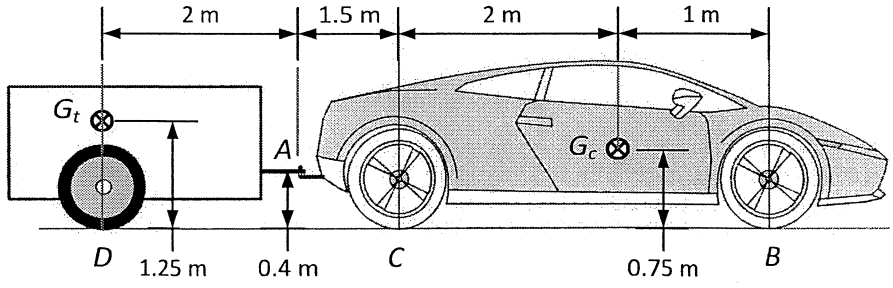


Fig. Q3

QUESTION 04

Car *B* is towing car *A* at a constant speed of 10 m/s on an uphill grade as shown in Fig. Q4. When the brakes of car *A* are fully applied, all four wheels skid. The driver of car *B* does not change the throttle setting or change gears. The masses of the cars *A* and *B* are 1400 kg and 1200 kg, respectively, and the coefficient of kinetic friction is 0.8. Neglecting air resistance and rolling resistance, determine,

(i) The distance traveled by the cars before they come to a stop,
(ii) The tension in the cable.

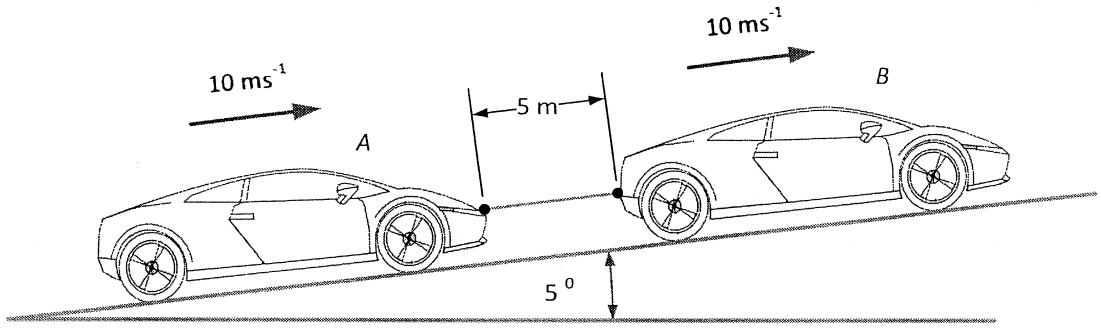


Fig. Q4

QUESTION 05

(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 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	- 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 $r_2 : r_1$	- 1.4:1

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 06

Determine the maximum theoretical speed that may be achieved over a distance of 60 m by a car starting from rest, knowing that the coefficient of static friction is 0.80 between the tires and the pavement and that 60 percent of the weight of the car is distributed over its front wheels and 40 percent over its rear wheels. Assume,

(i) Four-wheel drive
(ii) Front-wheel drive
(iii) Rear-wheel drive.

QUESTION 07

If an automobile's braking distance from 90 km/h is 45 m on level pavement, determine the automobile's braking distance from 90 km/h when it is,

(i) going up a 5° incline,
(ii) going down a 3-percent incline.

Assume that the braking force is independent of grade.

QUESTION 08

Power - speed characteristics of an engine of rear wheel drive vehicle is approximately given by the following relationship.

$$P_e = 571\omega_e + 0.87\omega_e^2 - 1.3 \times 10^{-3}\omega_e^3$$

where, P_e – Engine power in W
ω_e – Engine speed in rad/s

A hollow tube propeller shaft is required to transmit the maximum torque of the above engine in the first gear. The shear stress is not to exceed 63 MPa. Find the external diameter of the propeller shaft, if the ratio of the internal diameter to the external diameter is 3/8. Take the first gear ratio as 4.8

Torsion equation:

$$\frac{T}{J} = \frac{\tau}{r}$$

Where, T – Torque transmitted by the shaft
J – Polar moment of inertia of the shaft
r – Radius of the shaft
τ – Shear stress induced in the shaft

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