The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX6232/ DMX6532 Vehicle Dynamics**
Academic Year	:	2019/20
Date	:	16th October 2020
Time	:	1400 hours -1700 hours
Duration	:	**3 hours**

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **seven (07) questions and four (04) pages**.
3. **Answer any 05 questions only**. All questions carry equal marks.
4. Answer for each question should commence from a new page
5. Relevant charts/ equations are provided and do not use Red colour pen.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear handwriting.

Question 01 – (*20 marks*)

(a) Compare the fuel economy of a Hybrid Sedan and a light weight micro car for the following conditions

Parameter	Hybrid Sedan	Light Weight Micro Car
Coefficient of rolling resistance	0.01	0.01
Gross weight	1700 kg	1050 kg
Frontal projected area	1.2 m^2	0.85 m^2
Aerodynamic drag coefficient	0.26	0.2
Fuel consumption of the engine	0.140 kg/kWh	0.225 kg/kWh

You may assume that the Density of Air is 1.25 kg/m^3, in average, two passengers travel at a time, weight of a passenger is 75kg and the average speed of the vehicle is 80 km/h.

(b) Discuss the effect of engine efficiency, rolling resistance and aerodynamic resistance on the fuel economy.

Question 02 – (*20 marks*)

A car with curb weight of **1500kg** has been designed to carry a **600 kg** load including the driver. The unladen (when not loaded) ground clearance is 190 mm and should maintain minimum **160 mm** under fully laden (loaded with **500kg** load) condition. In order to maintain good ride comfort the damped natural frequency has to be maintained around **70 cycles per minute** to **120 cycles per minute**. To provide good adhesion between road and wheel the damping ratio has to be **0.7- 0.8**. Determine the appropriate stiffness of the spring and the damping coefficient for the damper.

Question 03 – (*20 marks*)

A four stroke four cylinder diesel engine is developing **38 kW** at **3800 r.p.m.** The Indicated mean effective pressure is **0.35 N/mm²** and the Mechanical efficiency is **82 %**. You may assume the following:

- The maximum pressure to be **10** times the indicated men effective pressure.
- Allowable stress of the material as **42 N/mm²**.
- Stroke is **1.5** times the bore diameter.

Determine:
i) bore and length of the cylinder
ii) thickness of the cylinder head

Question 04 – (*20 marks*)

An engine of a vehicle was tested at full throttle 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 **0.16 V²** respectively. The total mass of the car is **1500 kg**.

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** as shown in Figure Q04.
i) Determine the overall transmission efficiency and the overall gear ratio
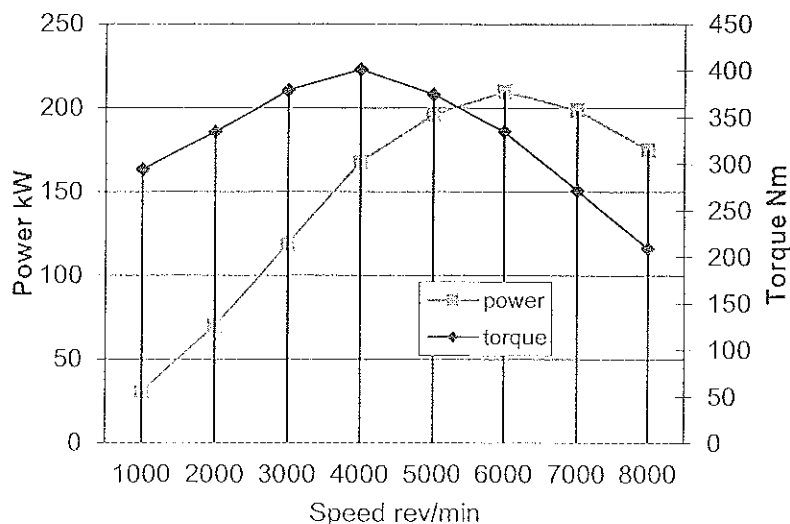ii) Acceleration at maximum engine torque condition.

Figure Q04

Question 05 – (*20 marks*)

(a) Explain the terms oversteer and understeer with respect to the dynamic behaviour of a vehicle.

(b) Explain how the degree of understeer/oversteer is determined using constant radius method experimentally.

(c) The Figure Q05(c) show, generation of forces in the contact patch when a wheel is accelerated. Explain the rolling resistance behavior of a tyre with the increase of linear velocity.

Figure Q05(c)
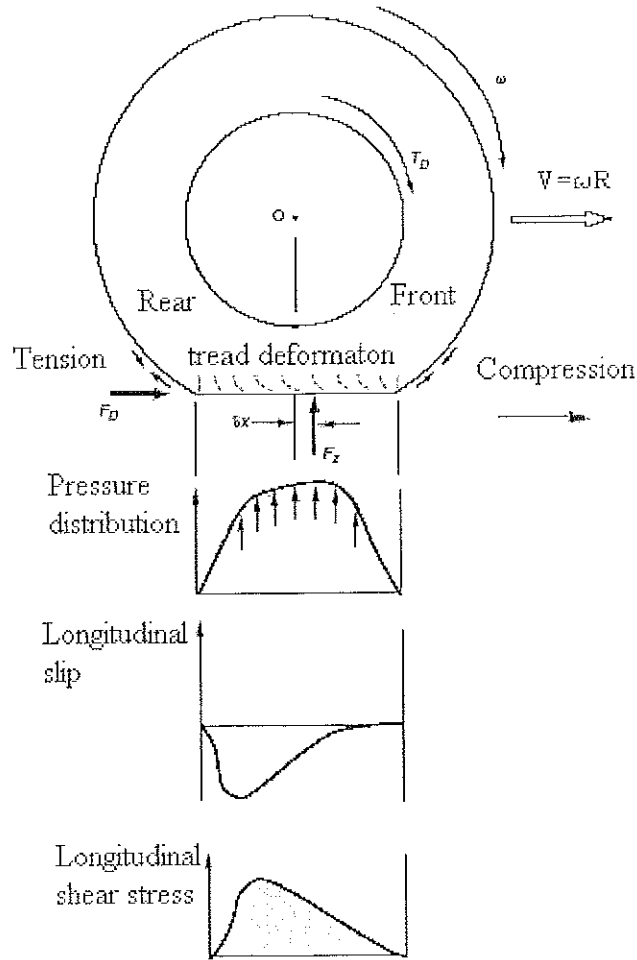
Question 06 – (*20 marks*)

Typical parameters for a vehicle are given below.

Speed of the vehicle	- 40 km/h
Wheel base	- 2640 mm
Height of the center of gravity above ground	- 610 mm
Distance from the rear axle to the center of gravity	- 1120 mm
Coefficient of friction between tyre and the road	- 0.4

Calculate the stopping distance when brakes are applied,
  i) Only on front wheels
  ii) Only on rear wheels
  iii) On all four wheels

Question 07 – (*20 marks*)

(a) A sketch of a typical sedan car is shown in Figure Q07. Sketch air streamlines assuming, that the vehicle is moving in forward direction.

Figure Q07

(b) Relating Figure Q07, illustrate pressure distribution over and under the body structure of the automobile.

(c) Briefly explain what boundary layer is, within the context of aerodynamics.

(d) By means of a sketch, explain what wake is and how the wake is formed an automobile