ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE, NIGERIA
DEPARTMENT OF AUTOMOTIVE ENGINEERING

SECOND SEMESTER EXAMINATIONS, 2018/2019 ACADEMIC SESSION

COURSE: ATE 304 Dynamics and Control I (3 Units)
CLASS: 300 Level Automotive Engineering

HOD'S SIGNATURE

TIME ALLOWED: 3hrs

INSTRUCTIONS: Answer any five questions **Date:** July 2019

Question 1

1a. Enumerate the necessary assumptions required for vehicle modeling? **3 marks**

b. (i) Consider the vehicle frame shown in Figure Q1b, If the vehicle speed $V_G = (80t - 15)$ km/hr with tire slip angle of 18° and yaw angle of 5°. Calculate the exact position of G (x_o^G, y_o^G) after 2 hours given that $[x_o, y_o] = [0, 0]$. **5 marks**

(ii) Show that the longitudinal and lateral acceleration of the vehicle could be obtained as follows;

$a_x = \dot{u} - u^2\beta\rho,\ a_y = u\dot{\beta} + \dot{u}\beta + u^2\rho$

Where β and ρ are kinematic ratios, u and v are the longitudinal and lateral velocities of the vehicle respectively. **4 marks**

Question 2

2a. Draw clear sketch of tire axis system and explain the details. **4 marks**

b. A car weighs 800 kg. If the tire prints as shown in figure Q2b of each radial tire is Ap = 4 x a x b =4 x 5 cm x 12 cm, determine the maximum normal stress in the tire and write the expression for the stress distribution over the entire tire print. **8 marks**

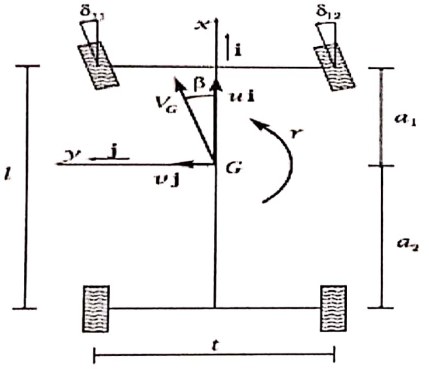


Figure Q1b

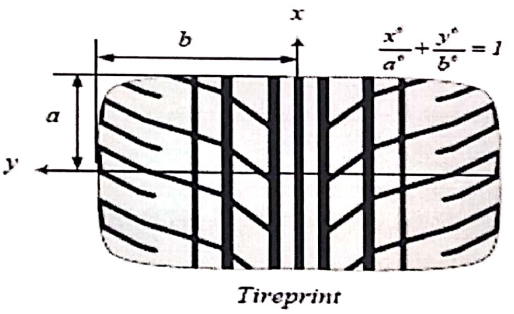
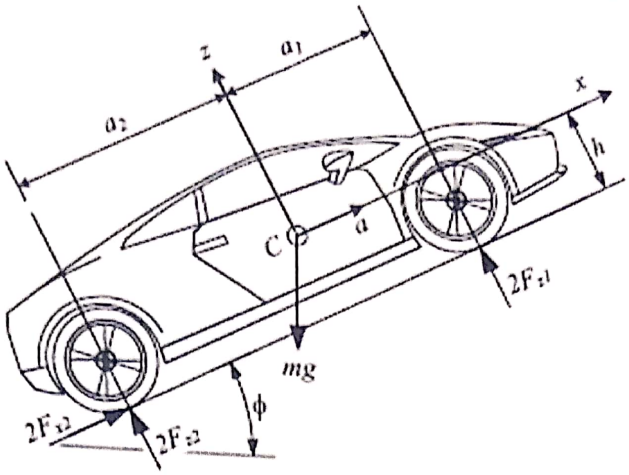


Figure Q2b

Question 3

3. Develop the expression for the brake force and reaction forces under the tires of a car parked on an inclined surface as shown in figure Q3. Determine the maximum inclination angle for the car.



$$\mu_{x_s} = 1$$
$$a_1 = 110\ \text{cm}$$
$$l = 230\ \text{cm}$$
$$h = 35\ \text{cm}$$

Figure Q3

12 **marks**

Question 4

4a. Explain the difference between dependent and independent suspension system **4 marks**

b. Enlist the primary functions of a suspension system. Explain various types of independent suspension system. **4 marks**

c. What do you understand by passive suspension system and active suspension system? **4 marks**

Question 5

5. A vehicle weighing 1600 kg is moving along a supposed straight and plane road at 88 km/hr. The front area of the vehicle is 2.0 m^2 and the coefficient of drag is 0.4. The aerodynamic resistance is acting on the centre of gravity. The wheel base of the vehicle is 2.8 m and the centre of gravity is at 1.2 m from the front axle and at 0.5 m above the ground. Identify and estimate the likely forces acting on the vehicle if the brake is under no acceleration, decelerating at 5 m/s^2. The density of air is 1.225 kg/m^3 12 **marks**

Question 6

6a. Enumerate the three basic functions of a vehicle brake system. **3 marks**

b. Show that the wheel rate of a four-wheel vehicle could be obtained as expressed;

$$k_w = \frac{W_s}{\delta_s} exp\left(\frac{v - v_s}{\delta_s}\right)$$

Where W_s is the wheel static load, δ_s is the static wheel displacement, v is the wheel deflection, v_s is the static wheel deflection. **9 marks**

Question 7

7. Briefly discuss with necessary models and diagram, the following forces acting on a vehicle in motion.

a. weight (due to gravity) **3 marks**

b. aerodynamic force **3 marks**

c. road-tire friction forces **3 marks**

d. road-tire vertical forces **3 marks**