ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE, NIGERIA

DEPARTMENT OF AUTOMOTIVE ENGINEERING

FIRST SEMESTER EXAMINATIONS

2020/2021 ACADEMIC SESSION

COURSE: ATE 505 – Automobile Vehicle Dynamics & Safety Control (3 Units)

CLASS: 500 Level Automotive Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer Question 1 and any other 4 from Questions 2 to 7

HOD'S SIGNATURE

Date: March, 2021

Question 1

i. With aid of appropriate diagrams, explain the two sets of coordinate system used in analyzing problems of Vehicle Dynamics
ii. Identify the types of motion associated with the coordinate axes, giving their names and showing their directions in the positive sense (for both translational & rotational)
iii. Explain the principle of manoeuvring in vehicle dynamics
iv. Define slip angle and camber angle and indicate their positive directions
v. Explain the source of lateral force in relation to rolling motion of a vehicle
vi. What is the interrelation between lateral force and sideslip?
vii. By means of a neat sketch, draw forces and moments acting on a pneumatic tyre and define each of the parameters involved
viii. Define pneumatic trail and aligning moment and write an expression connecting them
ix. Define cornering stiffness and camber stiffness.
x. Discuss the parameters affecting cornering properties of a tyre.
xi. Explain how a four-wheel steering system can improve low speed maneuverability and high speed cornering
xii. Distinguish between open loop and closed loop driving systems
xiii. What is safety control in the automobile system?
xiv. Define steering angle. Use sketch of steering angle vs. speed to illustrate the cases of under-steering, neutral steering and over-steering

Question 2

It is known that relation between lateral force and slip angle is largely derived from tests and can be expressed in graphical forms like the ones shown in the Figures 1a & 1b below.

(a) Interpret the figures and

(b) Explain their use in vehicle dynamics.

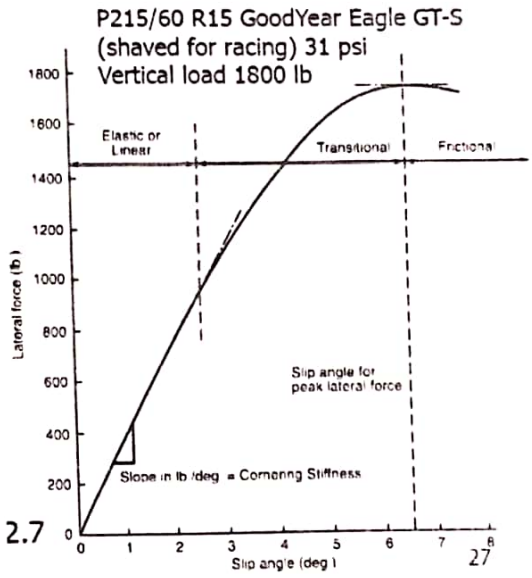

Figure 1a

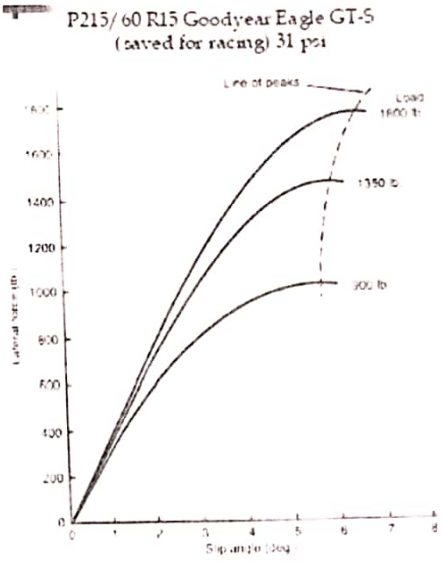

Figure 1b

Question 3

Figure 2 shows the bicycle (single track) vehicle model.

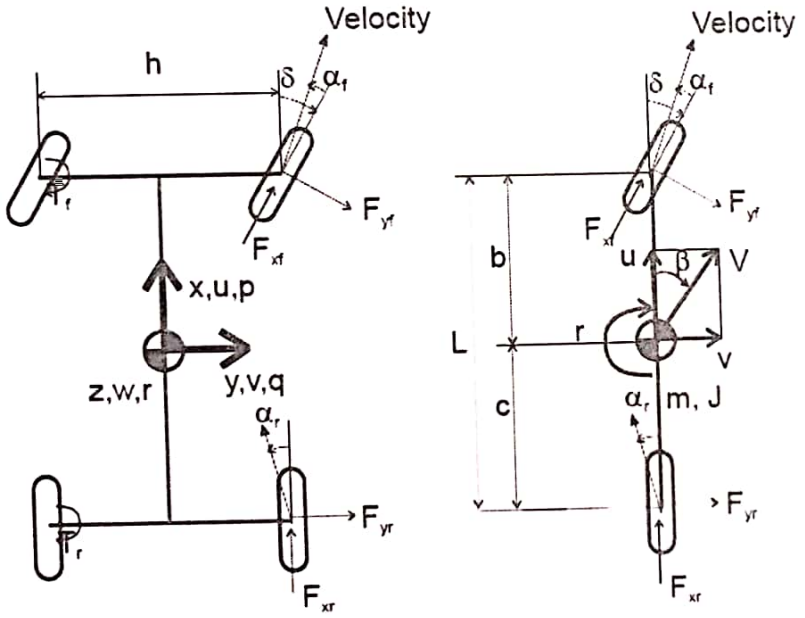

Figure 2

a) Draw the right side figure

b) Identify the parameters involved

c) State ***any three*** of the assumptions in the bicycle model

d) State ***any three*** of the requirements for low speed turning

Question 4

Figure 3 shows the Ackerman condition.

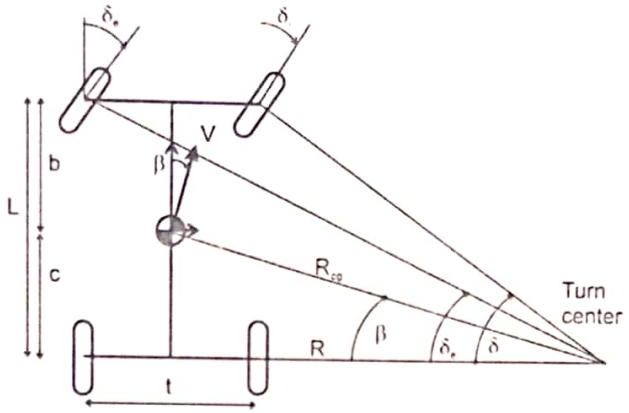

Figure 3

a) Name the variables shown. Use the kinematic (geometric) relations shown to derive the Ackerman condition

b) Show how the Ackerman condition meets the key requirement for low speed turning

c) Determine the turning radius for a vehicle having following dimensions and steer angle:
Wheel base= 2.62 m
Wheel track = 1.57m
Distance of CG from rear axle = 1.52 m
Steer angle of the steer angle of the inner wheel =12 deg

Question 5

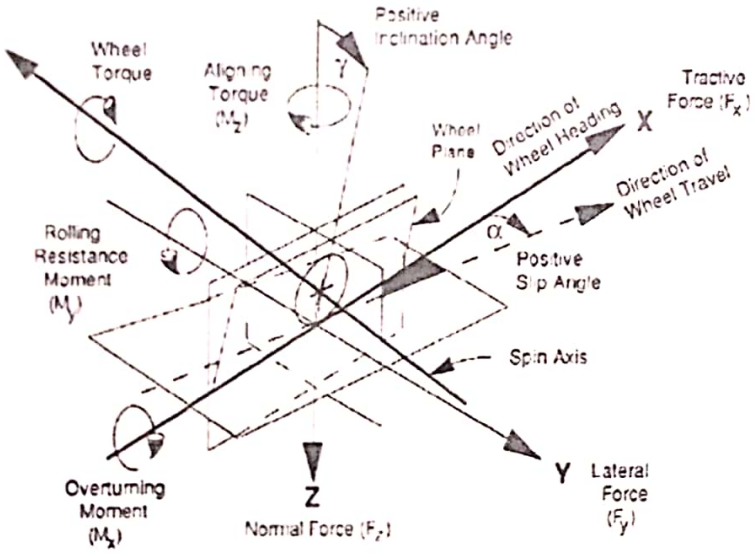

Figure 4

a) Using the sketch in Figure 4 above, explain the significance of any four key fundamental parameters used in vehicle dynamics

b) Use sketches to distinguish between lateral (side) slip and longitudinal slip

c) Draw a graph to show variation of tractive force with longitudinal slip

Question 6

The graphs in Figure 5 below describe the functional features of Lateral Forces in vehicle dynamics. Do the following:

a) Label the graphs
b) Explain the variables or parameters involved
c) Describe the relation between the graphs
d) State the results that can be derived from using the graphs

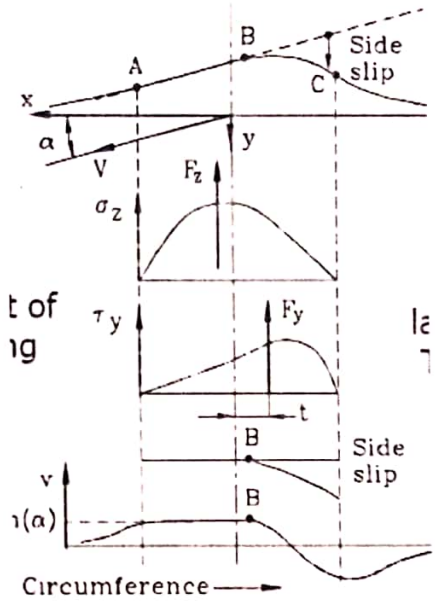

Figure 5

Question 7

Figure 6 below illustrates the main concepts in vehicle dynamics for deriving the equations of motion incorporating the following five parameters:

(i) Resistance forces, (ii) Tractive effort, (iii) Vehicle acceleration, (iv) Braking effort and (v) Stopping distance

a) Draw the figure and label it showing these parameters
b) Explain the significance of each of the parameters
c) Explain how empirical relations can be found for any two of the parameters

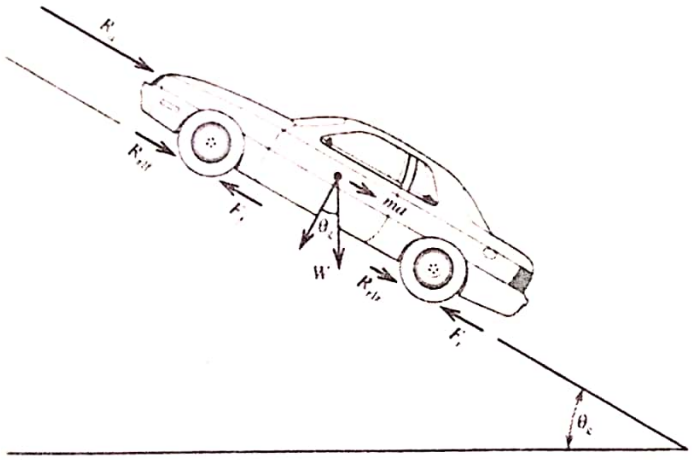

Figure 7