Exam. Code: 0943
Sub. Code: 33883

2124

B.E. (Mechanical Engineering)
Seventh Semester
MEC-703: Vehicle Dynamics

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Part.

x-x-x

Question 1:

a) Why do Noise, Vibration, and Harshness (NVH) characteristics significantly influence a driver's perception of vehicle handling quality?
b) Why is the Quarter Car Model often used to study vertical dynamics instead of more complex full-vehicle models?
c) Why does the understeer gradient provide a clear measure of a vehicle's handling characteristics?
d) Why does slip play a critical role in force development for tires during acceleration, braking, and cornering?
e) Why does load distribution change during acceleration and braking, and how does it affect vehicle stability?

[10 marks]

Part A

Question 2: Derive the expression for the dynamic load transfer during braking for a four-wheeled vehicle. Using the derived expression, explain how dynamic load transfer affects braking efficiency and stability.

[10 marks]

Question 3: The contact patch of a tire is critical for force transmission between the vehicle and the road. Analyze the role of contact pressure distribution in the following scenarios:

a. Uneven tire wear due to improper inflation pressure
b. The effect of a non-uniform pressure distribution on vehicle stability during high-speed cornering
c. How tire construction (e.g., radial vs. bias-ply) impacts contact pressure distribution and its implications for load-bearing and traction.
Suggest methods to experimentally measure and optimize contact pressure distribution in real-world applications.

[10 marks]

Question 4: Explain the process of lateral force generation in a tire when subjected to a slip angle. Discuss the key factors affecting lateral force. Additionally, analyze how ply steer and conicity influence the lateral force and discuss their implications for vehicle handling and tire alignment.

[10 marks]

P.T.O.

Part B

Question 5: Derive the equations of motion for the Bicycle Model and explain its application in analyzing vehicle lateral dynamics. Discuss the role of the following parameters in determining the stability and steering conditions of the vehicle: Tire cornering stiffness, Vehicle speed, Center of gravity location. Additionally, explain how the understeer gradient is derived from the model and its significance in assessing vehicle handling characteristics.

[10 marks]

Question 6: Explain the concept of rollover prevention in vehicles and the factors influencing rollover risk. Discuss the following:

a. The role of vehicle track width, center of gravity height, and suspension stiffness in determining rollover stability.

b. The methods used to calculate the critical lateral acceleration for rollover in both the half-car model and full-car model.

c. Strategies employed in modern vehicles, such as Electronic Stability Control (ESC), to reduce rollover risk.

[10 marks]

Question 7:

a. Discuss the key parameters that are evaluated subjectively by drivers during handling tests, such as steering feel, stability, and responsiveness.

b. Explain how objective metrics (e.g., understeer gradient, yaw rate gain) are measured and correlated with subjective feedback.

c. Highlight the challenges in bridging the gap between subjective impressions and objective measurements in vehicle development.

[10 marks]