

1. Preamble

This course enriches knowledge of the learners in analysing forces and moments exerted in vehicle under different loads, speed and road conditions in order to improve the comfort for the passengers and life of the various components of the vehicle.

2. Pre-Requisite

NIL

3. Links to Other Courses

- Finite element analysis

4. Course Educational Objectives

- To develop the basic knowledge of the students in automotive field in the areas of vehicle vibrations.
- To develop the skills of the students in stability of vehicles and their effects, related with longitudinal, vertical & lateral dynamics.

5. Course Outcomes

On successful completion of this course students will be able to:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basics of vibration, when the vehicle is at dynamic condition.	K2
CO2	Understand the tyre dynamics with respect to force & moments.	K2
CO3	Derive the effective cornering stiffness when considering the elastic elements in the wheel suspension and be able to analyse it's effect on the dynamic characteristics of the vehicle	K3
CO4	Understand the aerodynamic forces & moments, load distribution in the various vehicles.	K2
CO5	Test the effective steering geometry, vehicle handling & directional control of vehicle	K3

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	H	L	L						L
CO2	H	M	H	H	L	L						
CO3	H	M	H	H	L	L				L	L	
CO4	H	M	H	H	L	L						
CO5	H	M	H	H	L	L				H	H	

H- High; M-Medium; L-Low

7. Course Content**UNIT I Concept of Vibration**

Definitions- Modelling and Simulation- Global and Vehicle Coordinate System- Free- Forced- Undamped and Damped Vibration- Response Analysis of Single DOF- Two DOF- Multi DOF- Magnification Factor- Transmissibility- Vibration Absorber- Vibration Measuring instruments- torsional Vibration- Critical Speed.

UNIT II Tire Dynamics

L-9

Tire Forces and Moments- Tire Structure- Longitudinal and Lateral Force at Various Slip Angles- Rolling Resistance- Tractive and Cornering Property of Tire. Performance of Tire on Wet Surface. Ride Property of Tires. Magic Formulae Tire Model- Estimation of Tire Road Friction. Test on Various Road Surfaces. Tire Vibration.

UNIT III Vertical Dynamics

L-9

Human Response to Vibration- Sources of Vibration. Design and Analysis of Passive- Semi-Active and Active Suspension Using Quarter Car- Half Car and Full Car Model. influence of Suspension Stiffness- Suspension Damping- and Tire Stiffness. Control Law For LQR- H-Infinite- Skyhook Damping. Air Suspension System and Their Properties.

UNIT IV Longitudinal Dynamics

L-9

Aerodynamic Forces and Moments. Equation of Motion. Resistance- Rolling Resistance- Load Distribution for Three-Wheeler and Four-Wheeler. Calculation of Maximum Acceleration- Reaction Forces for Different Drives. Braking and Driving torque. Prediction of Vehicle Performance.

UNIT V Lateral Dynamics

L-9

Steady State Handling Characteristics. Steady State Response to Steering input. Testing of Handling Characteristics. Transient Response Characteristics- Direction Control of Vehicles. Roll Centre- Roll Axis- Vehicle Under Side Forces. Stability of Vehicle Running on Slope-Banked Road and During Turn. Effect of Suspension on Cornering- Latest Trends in Vehicle Dynamic Testing Like Four Poster- Multi Axis Simulator- Etc.

TOTAL: 45 Periods

8. Text Books

1. Singiresu S. Rao, "Mechanical Vibrations", 5 th Edition, Prentice Hall, 2010
2. Wong. J. Y., "Theory of Ground Vehicles", 3rd Edition, Wiley-Interscience, 2001
3. Rajesh Rajamani, "Vehicle Dynamics and Control", 1st edition, Springer, 2005
4. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc, 1992

9. References

1. Dean Karnopp, "Vehicle Stability", 1st edition, Marcel Dekker, 2004
2. Nakhaie Jazar. G., "Vehicle Dynamics: Theory and Application", 1st edition, Springer, 2008
3. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited 2004
3. Hans B Pacejka, "Tire and Vehicle Dynamics", 2nd edition, SAE International, 2005
- 65 John C. Dixon, "Tires, Suspension, and Handling", 2nd edition, Society of Automotive Engineers Inc, 1996
6. Jan Zuijdijk, "Vehicle dynamics and damping", Author House, 2009