Vehicle Dynamics

ME5670

Instructor: Ashok Kumar Pandey
Email: ashok@iith.ac.in

Venue: 111
Class timing
Tuesday: 4:00 – 5:25 PM
Friday: 2:30 – 3:55 PM
Fundamental Definitions

Vehicle Dynamics
It concerns with the movements of vehicles on a road surface.

Physical condition
Acceleration and braking, ride, and turning

Dynamic behavior
Forces on the vehicle due to tires, gravity, and aerodynamics.

Objective
Vehicle and its components are studied to determine forces produced by the sources at particular maneuver and trim condition. How the vehicle responds to these forces.

Representation
One mass approximation
Located at its C.G.

For acceleration, braking, and most turning analysis.

Two masses approximation
For ride analysis, wheels are treated as separate lumped masses

Body mass as sprung mass.

Wheel mass as unsprung mass.
Vehicle Dynamics Interaction

Separating driver from the disturbances

It implies the rejection of disturbance

Absence of disturbance amplification

Internally generated disturbance

Engine vibration and noise

Aerodynamic interaction (crosswinds, wakes, etc)

Road undulation

Vertical

Longitudinal

Lateral

Ride

Path

Stability

Agility

Fidelity

Linearity

Handling

Speed

Deamplify noise

Sensitivity

Accuracy

1D output

Refinement

Forces/effects

Ride

Path

Performance

Subjective

Objective
Vehicle Dynamics Model

Simplified view of a vehicle dynamics model and its interconnectivity with functional relationships.

http://www.policeone.com/police-products/training/simulator/articles/1716099-Understanding-simulated-vehicle-dynamics/
Course Content

- Fundamentals of Vehicle Dynamics, Free body diagram of vehicle under static and dynamic condition. Representation by quarter car model, half car model and full car model.

- Tire forces and moments, Different models tire forces and moments.


- General stability concept and its application in longitudinal motion.

- Concept of Vehicle Control using PID control system.

- Conditions of vehicle stability: Understeering, Neutral steering, Over steering.

- Vehicle Handling: Simplified equation for lateral motion under different steering condition.

- Vehicle driving: Acceleration and clutch operation.

- Vehicle braking: Performance characteristics and ABS system

- Concept of Driver-Vehicle model.

- Vehicle driveline modeling

- Dynamic analysis and performance characteristics of a comfort vehicle ride.
Grading Scheme

• Attendance: 5%

• Assignments: 10%

• Exam 1 (6 Feb): 20%

• Exam 2 (20 March): 20%

• Exam 3 (27 April): 30%

• A case study on vehicle dynamics (Saturday 21st April): 15%
References


Herb Adams, “Chassis Engineering: Chassis Design, Building & Tuning for High Performance Handling, Brownian Dynamics”, HP Trade, 1992

Softwares: Carsim, BikeSIM, ADAMS, SYSTEM MODELER/MAPLESIM, MATLAB SIMULINK, SOLID EDGE/UNIGRAPHICS,
Important Labs/Magazines

1. CARS – The center for Automotive Research at Stanford  
   (http://me.stanford.edu/groups/design/automotive/index.html)
2. Vehicle Dynamics and Controls lab (http://vehicle.me.berkeley.edu/)
6. Advanced vehicle dynamics laboratory - http://www.cvess.me.vt.edu/Labs/AVDL/advl.html
7. ARAI Pune https://www.araiindia.com/

7. http://www.me.utexas.edu/~longoria/VSDC/clog.html  Prof. R. G. Longoria

Society, Magazines and Journals:

2. SAE Journals - https://store.sae.org/saejournals/
3. International Journal of Automotive Technology,  
   http://www.springer.com/engineering/mechanical+engineering/journal/12239
6. Vehicle system dynamics -  
   http://www.tandfonline.com/doi/pdf/10.1080/00423114.2013.863363#.Usr4bbJ9mSo
Famous Car Makers

     http://www.volkswagen.co.in/en/volkswagen_world.html
     http://www.bridgestone.co.in/ (India)
Vehicle Data

05 Acura RSX http://www.me.ua.edu/me364/PDF/05Acura_RSX-05Chevrolet_CobaltSS.pdf
05 Audi A6Quattro http://www.me.ua.edu/me364/PDF/05Audi_A6Quattro.pdf
05 Chevrolet CobaltSS http://www.me.ua.edu/me364/PDF/05Acura_RSX-05Chevrolet_CobaltSS.pdf
05 Ferrari 612 http://www.me.ua.edu/me364/PDF/05Ferrari_612.pdf
05 Mercedes SLR McLaren http://www.me.ua.edu/me364/PDF/05Mercedes_SLR_McLaren.pdf
05 Morgan Aero8 http://www.me.ua.edu/me364/PDF/05Morgan_Aero8.pdf
05 Volkswagen Jetta http://www.me.ua.edu/me364/PDF/05Volkswagen_Jetta.pdf
06 Audi A32-0T http://www.me.ua.edu/me364/PDF/06Audi_A32-0T.pdf
06 Bentley Continental http://www.me.ua.edu/me364/PDF/06Bentley_Continental.pdf
06 BMW 330i http://www.me.ua.edu/me364/PDF/06BMW_330i.pdf
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