GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Electric Vehicle Technology)

Subject Code : 3726401

Subject Name : Vehicle Dynamics

WEF Academic Year:	2023-24
Semester:	II
Category of the Course:	Core

Prerequisite : Fundamental subject

Rationale :

This course of vehicle dynamics aims to understand the behavior of vehicles in motion, analyzing factors like acceleration, braking, cornering, and stability to optimize performance and safety. By delving into concepts such as tire mechanics, suspension systems, and vehicle control algorithms, engineers can design vehicles that handle predictably and efficiently across various conditions.

Course Scheme:

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Fundamental approach for Vehicle dynamics** Fundamental approach for vehicle dynamics model, Introduction of vehicle performance, handling and ride. vehicle fixed coordinate system, Earth fixed coordinate system, Euler angles, Lumped mass, sprung, un sprung mass, Dynamic axle loading, Static and dynamic loads acting on vehicle, Location of C.G.	05	10%
2	**Longitudinal dynamics** Vehicle road performance, Road loads, Rolling resistance, Traction, Low speed acceleration and high speed acceleration on level road and inclined road surface, Drive line dynamics, Braking performance, Stopping distance and time, Braking efficiency, Braking forces, Brake factor, Tyre-road friction, Brake proportioning, Anti-lock braking system.	10	25%
3	**Lateral dynamics** Steering linkages and kinematics, Steering geometry errors, Steering system forces and moments, Low speed turning and high speed cornering models, Understeer, Oversteer, Neutral steer and their effects, Effect of understeer gradient and measurement.	10	25%
4	**Vertical dynamics** **Suspension system:** Solid Axle Suspension, Independent Suspension, Roll Center and Roll Axis, Relative angles: castor, camber, toe and their effects, Anti-squat, Anti –dive	10	25%

	and Anti-pitch suspension geometry, Suspension effect on cornering. **Ride:** Newton's method and vibrations, ride excitation sources, Single DOF forced mass-spring-damper system, Quarter car model, Bicycle vibrating model of vehicle, Half car and body roll model, Active suspension system		
5	**Tyre dynamics:** Tire Components, viscoelastic property of tyre and their effects, Radial and Non-Radial Tires, Tread, Tire print, Wheel and Rim, Tyre dimensions, Tyre axis system, Tyre mechanic for force generation, Tractive and cornering properties of tyre, Camber thrust, Aligning moment, friction circle diagram, conicity and ply steer, tyre dynamic models.	7	15%
	Total		**100**

Reference Book:

1. Thomas D Gillespie, "Fundamentals of Vehicle dynamics", SAE USA 1992.
2. Wong J Y, "Theory of Ground Vehicles", John Wiley & Sons, New York, 1978
3. Milliken W F and Milliken D L, Race car Vehicle Dynamics, SAE.
4. R N Jazar, Vehicle Dynamics: Theory and Application, Springer.
5. Hans Pacejka, Tire and Vehicle Dynamics, Elsevier, 2012.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Apply fundamental theories to establish vehicle dynamics models.	AP
02	Interpret performance of vehicle under different road conditions and driving conditions.	UN
03	Analyse ride and handling behaviour of vehicle using various physical and mathematical vehicle models of steering and suspension system.	AN
04	Analyze impact of tyre characteristics and behavior on vehicle performance, handling and ride.	AN
05	Demonstrate proficiency in development of various dynamics models to simulate vehicle performance, handling, and stability and ride comfort.	EL

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Suggested Course Practical List:

1. Study vehicle dynamic terminology and measure vehicle dimensions to evaluate performance.
2. Locate the center of gravity of any four wheeler.
3. Modelling and simulation of battery electric vehicle to evaluate tractive, aerodynamic, rolling resistance power variation with vehicle velocity.
4. To study the effect of tyre pressure and tyre stiffness on the performance of the vehicle.
5. Locate roll center of vehicle suspension system.
6. Modelling and simulation of constant electric motor torque in battery electric vehicle to achieve average power and energy required to run the vehicle at desired speed.
7. Modelling and simulation of variable electric motor torque in battery electric vehicle to achieve average power and energy required to run the vehicle at desired speed.
8. To simulate and study a quarter car models using MBD (Multi Body Dynamics) software.
9. To simulate and understand behavior of sprung / un-sprung mass & lumped mass system MBD software.
10. Study of latest technologies available in vehicles helping to maintain stability of the vehicle on the road.

List of Laboratory/Learning Resources Required:

- Major Equipment: 1) Passenger car 2) MBD software (Preferred, any one among Mat lab, CarSIM, ADAM)
- Learning resources: http://nptel.ac.in (Vehicle Dynamics, IIT Madras)

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