

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL (I.C. ENGINE & AUTOMOBILE ENGINEERING) (11)

VEHICLE DYNAMICS

SUBJECT CODE: 2721110

SEMESTER: II

Type of course: Advanced/ Application

Prerequisite: - Fundamentals of Engineering mechanics, theory of machines.

Rationale: This subject is concerned with the acceleration, braking, ride and turning of Automobile vehicle on a road surface. Dynamic behavior is determined by the forces imposed on the vehicles from the tires, gravity and aerodynamics. The course is designed to provide understanding about effects of various unbalanced forces, its effects on the various components of vehicle and method to balance that unbalanced forces for getting smooth operation and long life of the vehicle. This course also aims to build higher level cognitive skill of future engineers for analyzing vehicle performance against various resistances acting on it during automotive operation, vibrations and its effects with respect to ergonomics of the vehicle. The knowledge of this subject is essential to design aerodynamics shapes of car body, to calculate equivalent weight and maximum acceleration, desired power to propel the vehicle.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	PA (V)		PA (I)			
					ESE	OEP	PA	RP		
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Unit-I Introduction: Introduction to Vehicle Dynamics, Lumped mass, Vehicle fixed coordinates system, Earth fixed coordinates system, Forces, Dynamic Axle loads, Static loads, low speed acceleration, Grade Loads	6	14
2	Unit-II Vehicle Performance: Acceleration Performance: Power limited acceleration; Traction limited acceleration, Braking Performance: Basic braking equations, Braking forces, Tire-Road Friction, Brake Proportioning, Anti-lock Brake System (ABS), Cruise Control and Adaptive Cruise Control (ACC).	7	17
3	Unit-III Road Loads: Aerodynamic Performance: Mechanics of air flow around a vehicle, pressure distribution on a vehicle, Aerodynamics forces, Drag force, Lift force, Side force, Pitching Moment, Yawing Moment, Rolling Moment, Crosswind Sensitivity, Aerodynamic aids to vehicle: Bumper Spoiler, Air Dams, Deck Lid Spoilers, Window and Pillar Treatments Rolling Resistance: Factors affecting Rolling Resistance, Tire Temperature, Tire inflation pressure/loads, Tire material and design, Velocity. Effects of Total road loads on fuel economy.	10	24
4	Unit-IV Ride Characteristics: Excitation Sources: Road Roughness, Tire/Wheel Assembly, Driveline excitation, Engine transmission. Vehicle	7	17

	response properties: Suspension Isolation, Suspension Stiffness, Suspension damping, Wheel hop resonance, Suspension nonlinearity, Rigid body bounce. Perception of Ride: Tolerance to Seat Vibrations, Other Vibration forms.		
5	Unit-V Cornering: Introduction, low speed turning, high speed turning, Suspension effects on cornering, Methods for measurement of understeer gradients: Constant radius method, Constant Speed Methods	6	14
6	Unit-VI Stability of Vehicles: Load distribution, calculation of tractive effort and Reactions for different drives, stability of a vehicle on a slope, on a curve and a banked road.	6	14

Reference Books:

1. Fundamentals of Vehicle Dynamics – Thomas D. Gillespie, 2013, Society of Automobile Engineers Inc., ISBN: 978-1560911999
2. Steering, Suspension & Tyres – J. G. Giles, Ilete Books Ltd., London
3. Mechanics of Road Vehicles – W. Steed, Ilete Books Ltd. London
4. Automotive Chassis – P. M. Heldt, Chilton Co. NK
5. Gillespie.T.D., “Fundamental of vehicle dynamic society of Automotive Engineers ",USA, 1992.
6. Vehicle dynamics and control by Rajesh Rajamani , Springer publication
7. Vehicle Dynamics : Theory and Application by Reza N Jazar, Springer publication
8. Theory of Ground Vehicles - J. Y. Woung - John Willey & Sons, NY

Course Learning Outcome:

After successful completion of the course, student will be able to:

- Understand basic principles of accelerating and braking a car.
- Identify the driving resistances and their influences on vehicle dynamics.
- Understand the discrepancy between demands and limits of powertrain.
- Understand the necessity of gears and clutch.
- Understand the correlation between braking, wheel load and recovery of energy.
- Understand various vehicle characteristic
- Understand ride characteristic
- Understand Concept of stability of vehicle and tractive effort

List of Experiments

1. Experimental study of mechanism for air flow over different geometry of vehicles.
2. Experimental studies of measurements of drag and lift coefficient for different geometry vehicle using wind tunnel apparatus.
3. To study Anti-lock Brake System (ABS) used in automobile vehicles.
4. To study Cruise Control and Adaptive Cruise Control (ACC) used in automobile vehicles.
5. To study advanced cornering and parking system used in automobile vehicles.
6. To study automatic wheel alignment and balancing system

Open Ended Problems:

To design/check aerodynamics shapes of various car bodies, to calculate equivalent weight and maximum acceleration, desired power to propel the vehicle by CFD analysis.

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.