Faculty Code: AU13

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Designation: LECTURER

Notes of Lesson
AU 2402 - VEHICLE DYNAMICS

OBJECTIVE

When the vehicle is at dynamic condition more vibration will be produced. It is essential to study about vibrations and how to reduce the vibration 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. In this subject these aspects have been given.

UNIT- I INTRODUCTION **9**

Fundamentals of vibration, single degree of freedom, two degree of freedom, multi-degree freedom, free, forced and damped vibrations, modeling and simulation studies, model of an automobile, magnification factor, transmissibility, vibration absorber.

UNIT- II STABILITY OF VEHICLES **9**

Load distribution, calculation of acceleration, tractive effort and reactions for different drives, stability of a vehicle on a curved track, slope and a banked road.

UNIT- III MULTI DEGREE FREEDOM SYSTEMS **9**

Closed and far coupled system, eigen value problems, orthogonality of mode shapes, modal analysis, forced vibration by matrix inversion.

UNIT- IV SUSPENSION, TYRES AND VEHICLE HANDLING **9**

Requirements, sprung mass frequency, wheel hop, wheel wobble, wheel shimmy, choice of suspension spring rate, calculation of effective spring rate, vehicle suspension in fore and aft, roll axis and vehicle under the action of side forces, tyre, dynamics, ride characteristics power consumed by a tyre. Oversteer, under steer, steady state cornering, effect of braking, driving torques on steering, effect of camber, transient effects in cornering.

UNIT- V NUMERICAL METHODS **9**

Approximate methods for determining fundamental frequency, Dunkerleys lower bound, Rayleighs upper bound, Holzer method for closed coupled system and branched systems.

TOTAL: 45

TEXT BOOKS

1. Rao J.S and Gupta. K “Theory and Practice of Mechanical Vibrations”, Wiley Eastern Ltd., 2002.
2. Giri N.K – Automotive Mechanics, Khanna Publishers, 2007.

REFERENCES

1. Ham B, Pacejka - Tyre and Vehicle Dynamics - SAE Publication - 2002.
2. Ellis.J.R - “Vehicle Dynamics”- Business Books Ltd., London- 1991
3. Gillespie T.D, “Fundamentals of Vehicle Dynamics”, SAE USA 1992.
4. Giles.J.G.Steering - “Suspension and Tyres”, Illiffe Books Ltd., London- 1998

UNIT I

INTRODUCTION

Fundamentals of vibration, single degree of freedom, two degree of freedom, multi-degree freedom, free, forced and damped vibrations, modeling and simulation studies, model of an automobile, magnification factor, transmissibility, vibration absorber.

Degree of freedom

The number of degree of freedom of a mechanical system is equal to the minimum number of independent co-ordinates required to define completely the positions of all parts of the system at any instance of time.

Multi degree of freedom

A multi degree of freedom system is one for which 2 or 3 co-ordinates are required to define completely the positions of the system at any instance of time.

Free vibration

When there is no external force acts on the body after giving an initial displacement, then the body is said to be under free or natural vibration.

Forced vibration

When the body vibrates under the influence of external force the body is said to be under forced vibration. The frequency of forced vibration is called forced frequency.

Damped vibration

When there is reduction in amplitude over every cycle of vibration, the motion is said to be damped vibration.

Magnification factor

It is the ratio between the maximum actual amplitude of the body and the maximum actual amplitude of the road.

Transmissibility

It is the ratio between the force transmitted to the body and force acting on the road

Vibration absorber

Vibration absorber is an additional spring mass system used to make the amplitude values of vibration equal to zero.

UNIT II

STABILITY OF VEHICLES

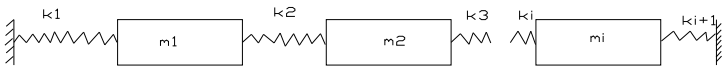
Load distribution, calculation of acceleration, tractive effort and reactions for different drives, stability of a vehicle on a curved track, slope and a banked road.

For derivations and numerical, the students are advised to refer Text Book 2

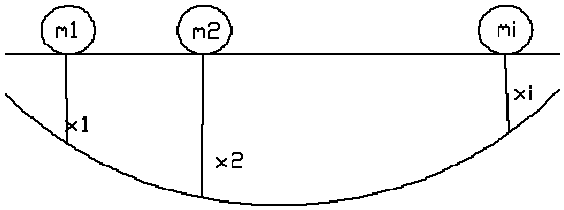
UNIT III

MULTI DEGREE FREEDOM SYSTEMS

Closed and far coupled system, eigen value problems, orthogonality of mode shapes, modal analysis, forced vibration by matrix inversion.



The above figure represents a typical close couples system.



The above figure represents a typical far couples system.

EIGEN VALUE PROBLEMS

If a spring mass system is represented by matrices, the eigen value can be used to find the natural frequencies of he system

ORTHOGONALITY OF MODE SHAPES

The mode shapes of a dynamic system exhibit orthogonality property, which is very useful in simplifying the analysis for forced and transient vibrations.

MODAL ANALYSIS

When the degree of freedom of the system is large and / or when the forcing functions are non-periodic, in such cases a more convenient method known as modal analysis can be used to solve the problem. In this method, the expansion theorem is used, and the displacements of the masses are expressed as a linear combination of the normal modes of the system.

UNIT IV

SUSPENSION, TYRES AND VEHICLE HANDLING

Requirements, sprung mass frequency, wheel hop, wheel wobble, wheel shimmy, choice of suspension spring rate, calculation of effective spring rate, vehicle suspension in fore and aft, roll axis and vehicle under the action of side forces, tyre, dynamics, ride characteristics power consumed by a tyre. Oversteer, under steer, steady state cornering, effect of braking, driving torques on steering, effect of camber, transient effects in cornering.

REQUIREMENTS OF A SUSPENSION SYSTEM

- Stiffness/Displacement bound
- Compatibility
- Min wear
- Maintenance low
- Initial cost low

WHEEL HOP

It is the vertical oscillating motion of the wheel between the road surface and the spurng mass.

WHEEL WOBBLE

It is the horizontal vibration of front axle assembly around the longitudinal axis

STEADY STATE HANDLING CHARACTERISTICS OF A VEHICLE

Steady state handling characteristics is concerned with the directional behavior of a vehicle during a turn under non-time varying conditions.

UNIT V

NUMERICAL METHODS

Approximate methods for determining fundamental frequency, Dunkerleys lower bound, Rayleighs upper bound, Holzer method for closed coupled system and branched systems.

Students are required to understand different numerical methods.