GUJARAT TECHNOLOGICAL UNIVERSITY

AUTOMOBILE ENGINEERING (02)
NOISE, VIBRATION & HARSHNESS AND SAFETY
SUBJECT CODE: - 2180209
B.E 8TH SEMESTER

Type of Course: - Advanced Application

Pre-requisite:- Dynamics of Machines, Vehicle Dynamics.

Rationale: Understanding the importance of Noise, Vibrations & Harshness related sources and mandatory requirements in Vehicular applications. Parameters affecting design criteria, construction & architecture, as well as operational systems for reduction of NVH. Subjectively evaluate vehicle performance characteristics for functional requirements including mandatory - safety parameters. In order to better prepare today's automotive engineer for this course, to help in understanding fundamental principles and automotive system applications, along with associated improvements implemented in different models of vehicles.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	1	0	4	70	20	10	30	0	20	150

CONTENT:-

S.N.	Course Content	Total Hours	% Weightage
1	**INTRODUCTION TO NHV:** Definition of Noise, Vibrations & Harshness in reference to Vehicular application. Study principles of Rolling, Pitch & Yaw velocity and moments.	2	05
2	**FUNDAMENTALS OF NOISE AND VIBRATIONS:** Basic Concepts of Vibrations: Simple Harmonic Motion, Frequency of Vibrations, Period, Natural Frequency, Resonant Frequency, Amplitude of vibrations. Un-Damped & Damped Vibrations. Types of Vibrations: Free & Forced Vibrations induced for Single degree of freedom & Multi degrees of freedom. Basic Concepts of Noise: Fundamentals of Acoustics. General Types of sound wave propagations- wave equation, specific acoustic impedance, Plane wave & Spherical waves. Structure borne sound and air borne sound. Interior noise sources and levels of noise. Anatomy of human ear and mechanism of hearing. Sound intensity, summation of pure tones (decibel addition), subtraction & averaging. Octave and Octave bands.	05	15
3	**CHARACTERISTICS & SOURCES OF VIBRATIONS:** **Power Train:** Engine, Clutch, Transmission, Propeller shaft, Differential, Drive shaft, Trans axle. Power train mounts. **Suspension:** Different types of suspensions, Dampers, Rubber & Rubber embedded Metallic bushes. Passive and Active suspensions.	5	15

	Road roughness & irregularities, Tyres & Wheels **Low frequency vibrations:** due to body structure, Seat mounting, seat materials and Steering assembly components.		
4	**VIBRATIONS MEASUREMENT TECHNICS AND CONTROL:** Vibration measuring Instruments: Vibration pick-up, Types of Transducers, Vibrometer etc. for measurement of Frequency of vibrations, Period, Amplitude, Velocity and acceleration parameters. Methods of Control and vibrations isolation: Different Types of Dampers, Vibrations absorber / isolator (including viscous damping, sandwich construction).	**10**	**20**
5	**SOURCES OF NOISE, NOISE MEASUREMENT TECHNICS AND CONTROL:** Noise specifications and mandatory standards regulations. Brake Squeal noise, Pass-by Noise, wind noise, squeak noise and rattle, interior noise (including noise emitted by running of accessories, indicators and all buzzers). Power train, Engine Air Intake & Exhaust noise, Engine accessories, cooling system and vehicle body protrusion noise, under body protrusion noise. Noise due to Tyre-Road friction and slip characteristics. **Noise Measuring Instruments:** Microphone, Sound intensity probes. **Noise Control:** Damping treatment methods, Control through isolations and noise absorbing materials and structure. Active and semi-active control of noise. Study of anechoic chamber.	**10**	**20**
6	**Harshness:** Definition. Its effect and acceptable degree of Harshness. Perception of Ride comfort i.e. psychological effects of Noise & Vibrations. Study of **NVH - Legislations** applicable for vehicles in India.	**5**	**10**
7	**Safety:** Passive safety Active safety. Study of Safety Regulations for vehicular application.	**5**	**10**
8	**Introduction to software applications (Capabilities & Limitations of different software's) for analysis of NVH.**	**03**	**05**
		45	**100**

SUGGESTED SPECIFICATION TABLE WITH MARKS (THEORY):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
15	15	25	10	5	-

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyse and E: Evaluate

NOTE: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

REFERENCE BOOKS:

1. Vehicle Noise, Vibration, and Sound Quality by Gang Sheng Chen, SAE International Publications.
2. Fundamentals of Noise and Vibration, by Norton M.P, Cambrige University Press
3. Mechanical Vibrations & Noise Control, by Dr. Sadhu Singh, Khanna Publishers.
4. Mechanical Vibrations by G.K.Grover, Published by Nem Chand & Bros, Roorkee, India.
5. Mechanical Vibrations, by S.S.Rao, Pearson.
6. Theory of Vibration with Applications, by W.T.Thomson & M.D.Dahleh, Pearson Education.
7. Dynamic Vibration Absorbers, by Borris and Kornev, John Wiley Publications.

8. Noise Control of Internal Combustion Engine, by Baxa, John Wiley Publications.
9. Acoustic Duct and Mufflers by Munjal N.S, John Wiley Publications.
10. Mechanical Vibrations, by Dr. V.P.Singh, Published by Dhanpat Rai & Co (P) Ltd.
11. Vibrations and Noise for Engineers, by Kewal Pujara, Dhanpat Rai & Co (P) Ltd.
12. Text Book of Mechanical Vibrations, by Rao V. Dukkipati and J. Srinivas, Prentice-Hall of India Pvt. Ltd
13. Brake NVH Testing and Measurements by J.K.Thompson, SAE International Publications.

COURSE OUTCOME:

1. Students will become familiar with the basic terminologies of Noise, Vibration & Harshness – NVH, which is a major focus for high end luxury vehicles manufacturers, in the current times.
2. Students will acquire Comprehensive, theory based understanding of natural and physical sciences along with engineering fundamentals related to Sources of Vibration and Noise applicable to the automobile engineering discipline and possibility of modifications and improvements.
3. Student will understand Application of engineering techniques, tools, for measurement methods in order to learn to control and solve complex Vehicle vibrations behavior /as well as performance problems.
4. Student will learn Application of systematic engineering synthesis and design processes for eliminating or reducing the Vibration, Noise to reduce irritation to occupants and achieve improvement in perception of ride comfort.

TUTORIALS:

1. Write Definition of Noise, Vibrations & Harshness in reference to Vehicular application. Discuss / Study principles of Rolling, Pitch & Yaw velocity and moments. Write the phenomena of Rolling, Pitch & Yaw velocity.
2. Discuss and write: Basic Concepts of Vibrations e.g. Simple Harmonic Motion, Frequency of Vibrations, Period, Natural Frequency, Resonant Frequency, and Amplitude of vibrations. Un-Damped & Damped Vibrations.
3. Write Types of Vibrations: Free & Forced Vibrations induced for Single degree of freedom & Multi degrees of freedom. Vibration measuring techniques and methods of Control.
4. Study different sources of Vibrations: Power Train components & assemblies. Road roughness & irregularities, Tyres & Wheels, Low frequency vibrations: due to body structure, Seat mounting, seat materials and Steering assembly components.
5. Study Different types of suspensions, Dampers, Rubber & Rubber embedded Metallic bushes and also the Passive and Active suspensions.
6. Understand Fundamentals of Acoustics, General Types of sound wave propagations-wave equation, specific acoustic impedance, Plane wave & Spherical waves. Differentiate between Structure borne sound and air borne sound, and Interior noise sources and levels of noise. Noise level measurement techniques and control methods.
7. Study of Anatomy of human ear and mechanism of hearing. Learn Sound intensity, summation of pure tones (decibel addition), subtraction & averaging. Understand Octave and Octave bands.
8. Understand effect of Vibration & Noise, define Harness. Perception of riding comfort.
9. Legislations on Vibrations & Noise levels.
10. Legislations for Safety standards and test methods.
11. Study of applications of MAT LAB / LAB VIEW / SIMULINK /CFD / Hyper works.

List of Open Source Software/learning website:

1) **https://www.araiindia.com**
2) www.**sae**.org

ACTIVE LEARNING ASSIGNMENTS:

Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.