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3.3.2 Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during a year 2021-22

Sr. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Name of the conference
1	Dr Unde M G	NA	Current harmonic Compensation using a Controlled Eight Switch Power Conditioner	IEEE sponsered, 2nd Global conference on "Advances in Technology"(GCAT-2021) Bengaluru India	IEEE sponsered, 2nd Global conference on "Advances in Technology"(GCAT-2021)Bengaluru India
2	Dr Unde M G	NA	Implementation of Three Phase Photo Voltaic (PV) Integrated Unified Power Quality Conditioner (UPQC)	2nd international conference onSmart Electronics & Communication(ICOSEC-2021) 7-9 Oct 2021 , Trichy India	2nd international conference onSmart Electronics & Communication(ICOSEC-2021) 7-9 Oct 2021 , Trichy India
3	Prof. R. J. Patil	NA	NodeMOU base Automatic Electricity Meter Reading Using IOT.	2nd international conference onSmart Electronics & Communication(ICOSEC-2021) 7-9 Oct 2021 , Trichy India	2nd international conference onSmart Electronics & Communication(ICOSEC-2021) 7-9 Oct 2021 , Trichy India

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(1)

Current harmonic Compensation using a Controlled Eight Switch Power Conditioner

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Abstract **– As the power system is travelling towards Smart grid architecture, the spread of multiple electronic equipments, switched power electronics, non-linear components and other, the power system is highly infected with current harmonics and related side effects.**

Multiple research activities are aligned towards solving this issue, and many techniques have come up using various circuitry. In this study, focus is kept on switched power conditioner system that filters out the unnecessary harmonics in the line. Here, enhancement of power quality for harmonic compensation with fuzzy logic controller (FLC) stages good static and dynamic performance. Using MATLAB Simulink study, performance of eight switch power conditioners is studied and result is discussed.

Keywords- Power system, Current Harmonics, non-linear systems, power conditioner

I. INTRODUCTION

With the rapid wingspread of power electronics and switching based devices in the power network, the fraternity of power quality concerns over an alarm-ringing scenario where the power system gets hugely prone to current harmonics and their ill-effects. The non-linearity absorbed in the network drastically affects the performance of the electrical devices connected to the network. Owing to relatively low acquisition costs and excellent effectiveness, a tuned LC filter bank and/or a high-pass filter are frequently employed to diminish harmonics. They do, nevertheless, have the accompanying downsides:

- Source impedance sturdily influences filtering characteristics.
- Parallel resonance amongst supply and passive filter motives amplification of harmonic currents at supply facet at, unique frequencies.
- As voltage aberration causes excessive harmonic currents to stream through passive filters, they become resonant with the source.

Harmonic currents which are generated with aid of using numerous non-linear systems brings about distortion of the delivery voltage because of finite grid impedances and motives severe harm to any attachd electric device to grid. Thus, without right compensation, excellent strength can deteriorate. So as to remove the harmonics in utilities, passive filters were historically used for their low heads and excessive efficiency.

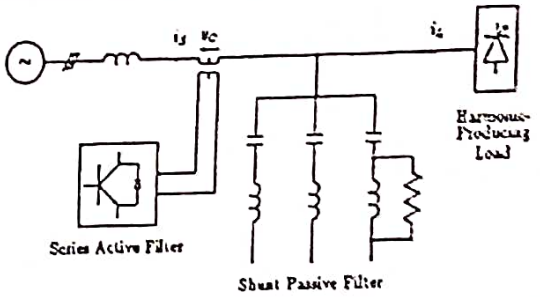

Fig. 1. Amalgamation circuit with shunt passive plus series active filter

Shunt related passive filters, tuned to impedances of dominant harmonic frequencies to take in harmonics, and have been broadly used. However, those passive filters have a couple of drawbacks like constant reactive strength compensation, the lack of ability to compensate unbalance, resonance phenomenon with the grid impedance.

II. ESTIMATION OF HARMONICS

The assessment of harmonic portions in voltage waveforms through reliability assessments method based on PQ standard (IEC 61000-4-30, 2008). The following parameters are taken care:

A. Total Harmonic Distortion (THD):

It is the standard measure of noise present in the current. THD is the amount of harmonics on a line compared to the line fundamental frequency, e.g., 50Hz. The THD considers all of the harmonic frequencies on a line.

$$THD = \frac{\sqrt{\sum_2^{h_{max}} M_h^2}}{M_1}$$

M_h is the harmonic function's amplitude, and h is the harmonic number. The sine waveform seems to have become warped if the THD score is higher than zero. The voltage THD ought not surpass 5%, and the current THD ought not surpass 20% of the fundamental frequency for optimum performance.

978-1-6654-1836-2/21/$31.00 ©2021 IEEE

2021 2nd Global Conference for Advancement in Technology (GCAT) | 978-1-6654-1836-2/21/$31.00 ©2021 IEEE | DOI: 10.1109/GCAT52182.2021.9587

Implementation of Three Phase Photo Voltaic (PV) Integrated Unified Power Quality Conditioner (UPQC)

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2021 2nd International Conference on Sustainable Technologies in Electronics and Communication (ICOSTEC) | 978-1-6654-3368-6/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICOSTEC51465.2021.9551823

Abstract:

The renewable systems are becoming popular now a days, with enhancement in the performance. Solar based systems for electricity generation are being installed in India with the keen interest and support of Indian government. The performance of such system is enhanced in terms of the efficiency, harmonic reduction and reliability over the years.

The researchers have presented various configuration and control techniques implementation in last few years for the solar based systems. Authors have presented the implementation of Three Phase-Solar PV Integrated UPQC in this paper. The system in simulated using MATLAB Simulink and the results are presented.

The series-shunt compensators along with power point tracking to get maximum power is found useful in terms of performance enhancement of the system. Implementation of PV-UPQC results in controlled output with respect to harmonic and reactive power performance. Power control devices helps in improvement of the sag-swell performances of the system.

Keywords: Renewable Systems, PV, UPQC, Solar PV, MPPT, etc.

I. Introduction

India is reaching toward 200 GW electricity demand in the recent days. With such a huge demand of electricity, it has become very important for India to use the geometrical and weather conditions which helps in solar based electricity generation.The enhancement in the performance of the solar based generating systems leads to new installations in India. Indian government is looking forward to increase the solar generation capacity of the country to great extend in next ten years.

The general problem with the solar based generation is the harmonics due to the use of controlled electronic switches. Another severe issue is to handle the sag-swell events on the grid connected system. The use of power tracking technique has become very popular in such systems to enhance the generation per unit area of the solar PV panel.

PV-UPQC system is enabled to compensate the voltage with implementation of series-shunt compensation. The quality of power is enhanced with such system with insertion of controlled voltage at common coupling point [1]. The filtered power for the distributed generation achieved with anticipated system. Capacitor in the DC link is providing flexibility of the supply as per need [2]. Clean energy is always the first choice for electricity generation with added advantage of environmental protection. The developments of power electronics leads to design of application such as power controllers and compensators for solar PV applications [3].

Distributed generation is the future of electricity generation in coming decade. With the developments in the control strategies and enhancement in the performance of solar based generation systems, it is possible to install the distributed systems for generation of electricity [4].

The grid connected systems with the challenges of events occurrence on the system are passing through the developments in order to enhance the control of power [5]. For performance analysis of such systems, the design is based on artificial neural network and other strategies [6].

The common DC link gives advantage of better control with addition of filters. The voltage injection at the common point of coupling is enhancing sag-swell performance [7].

P&O method implemented with MPPT results in better performance of the system. The current control is implemented in triggering of power electronics devices for accurate operation [8]. The management of the battery with various techniques is another area for enhancement of performance [9].

Injection of active power in the system help in enhancing the reactive power profile of the system by increasing the total active power with respect to the reactive power produced due to harmonics and sag-swell related problems [10,11].

The induction motors are contributing the most in harmonic injection in the system [12]. Dynamic restorer of voltage enhances the power quality when used for compensation in series [13-14].

Authors have presented the implemented UPQC system in this paper.The simulation results are discussed and presented in the paper in detail.

II. Objectives of the Work:

Thedistributed systems are becoming very popular in renewable generation. The PV systems are now a days distributed all over India.The nonlinear nature of the load creates the severe problems in the performance of the system. To overcome these issues, the work is carried out to achieve the following objectives.

- Reducing the harmonics from the supply
- Mitigating voltage sag and swell for PV based generation system
- Implementing the UPQC model for PV system

Proceedings of the Second International Conference on Smart Electronics and Communication (ICOSEC)
IEEE Xplore Part Number: CFP21V90-ART; ISBN: 978-1-6654-3368-6

NodeMCU Based Automatic Electricity Meter Reading Using IOT

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***Abstract*— The use of electricity is increasing continuously day by day in our country. With the rapid development in technologies and wireless communication in industries, the advancement in technology changes the people life, decrease their manual efforts & also rises the economic growth of the country. Before manual reading technique was used everywhere, for that worker have to work hard. A person from the Electricity office came into our house, note the reading manually, calculate or estimate the bill consumed by a consumer & send it to them. In each area, each house worker has to go to note the reading & if the consumer is not present then he has to again revisit to take the reading, so it will be a difficult task for them to manage & calculate the bill. While doing all these tasks, sometimes they do mistakes in taking a reading or calculating the bill, sometimes misplace the bill like one consumer bill goes to another, due to that it is not possible to get an accurate bill or consumer obtaining extra amount as compared to their consumption unit. All the issues can be resolved with the help of only IoT, it is used to give accurate meter reading using the internet without human intervention, used to reduce the power consumption & used inadequate amount, also protect the system from theft if someone tries to misuse the electricity or if the user did not paid the given bill whatever they consumed at a given time, then by using relay host will cut the supply automatically from the remote area. In this project, a normal meter is converted to a smart meter reading with the help of NodeMCU & IoT. The consumer can manage the power consumption as per need as the consumer can see the daily consumption of power. If any theft occurs then in meter, it shows theft or bill is not paid on time by consumer then message will send to the consumers through NodeMCU & automatically supply will cut using a relay.**

Keywords— Internet of Things, smart Bill system, Node Microcontroller Unit, cloud server, smart reading meter.

I. INTRODUCTION

To lower the person's efforts to make their life easy, certain technical techniques are developing every day and in between this technology, IoT is the advanced technology that gives access to communicate with components to interact with each other in the network using the net. Taking things to use in everyday life, embedding all these devices with other electronic devices, apps, software, different sensors, networks and enabling them all to collect and send data from one device to other without any human interaction. Because of the rapid development of IoT technologies in Wireless technique, networks with sensors, and communicate with devices wirelessly, and cloud server techniques. The several uses of the Internet of Things like in-house, large industries, companies, cars, factories, watches, phones, automation fields, etc. Using IoT means by using the internet a user can control, operate & monitor all these by internet from anywhere so by adding *IoT with* normal devices we make it all these *smart techniques*. Among these, all the applications one of the useful & most important uses of IoT is in energy regulation and intelligent billing system which keeps away people interference in smart grid. A smart grid is a way that allows consumers & electricity boards to communicate with each other. In the market, there are mostly 2 electronics meters available first is an electromechanical meter & the second is an electronic meter. Electromechanical meters are mostly found in village areas & electronics meters are mostly found in city areas replaced by electromechanical to electrical. Electronic meters properly have a display board or liquid crystal display to show the meter reading. The billing details as well as power details without interrupt transmitted with the help of IoT & it can be reviewed by the host.

Theftling electric power is one of the crimes, it is against the law & illegal way. if someone tried to steal the electric power then they will be punished for that they will go to prison or have to pay the fine as a penalty for doing crime. If someone tries to use the electricity in an illegal way, so to detect such people unit of theft detect & control system is employed. Theft of electricity can be prevented by using a meter tamper switch on the box of the meter means a magnetic stick is present almost about the meter box if someone tried to theft then due to meter tamper switch neutral line will disconnect & short the Current Transformer phase coil & break the supply of power. This is the smart way to identify the person who is trying to theft the electric power & also control the theft condition. Here we are using the current sensor not only to detect the current of a particular load but also to detect & measure the neutral current of the load. The microcontroller NodeMCU is going to be used to send the power signal to WIFI. If the meter box is open the online message will display that meter tampering occurred. Hence, the retailer or host will easily get the information if anyone tries to use or consume the electricity illegally from a meter then they will easily know & identify that person. If in case of theft condition occurs in the system then a relay is used in a meter that disconnects the electricity power supply connectivity. It's observed that nowadays, IOT based meters can identify the unwanted use of power as well as its proper efficiency to the system in numerous areas.

Existing system - The present system will generate the bill in the last day of the month. If the consumers are increased then it directly proportional to the uses of the electricity consumption so increasing in consumer there will be a

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3.3.2 Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during a year 2021-22

Sr. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Name of the conference
1	Dr. Jagtap H. P.	Lecture Notes in Mechanical Engineering (LNME)	Use of Analytic Hierarchy Process Methodology for Analyzing Existing Motorcycle Helmet Design Concepts	Proceedings of RAM 2021 Lecture Notes in Mechanical Engineering (LNME)	Recent Advances in Manufacturing Modelling and Optimization
2	Pitambar Gadhave	Lecture Notes in Mechanical Engineering. Springer, Singapore	Investigative Study on Triplex Tube Heat Exchanger with Stearic Acid as Phase Change Material	The International Conference on Advanced Materials and Modern Manufacturing	The International Conference on Advanced Materials and Modern Manufacturing
3	Dr. Ubale A. B.	EasyChair Preprint	Experimental and FEA of Optimized Existing Lower Control Arm	NA	NA

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Lecture Notes in Mechanical Engineering

Shailendra Kumar
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Panagiotis Kyratsis *Editors*

Recent Advances in Manufacturing Modelling and Optimization

Select Proceedings of RAM 2021

Springer

Use of Analytic Hierarchy Process Methodology for Analyzing Existing Motorcycle Helmet Design Concepts

S. R. Bajare, A. K. Bewoor, and H. P. Jagtap

1 Introduction

In India, wearing helmets while riding bicycles is the biggest problem. Riding a two-wheeler without wearing helmets has resulted in severe brain injuries as well as fatality. A report "ROAD ACCIDENTS IN INDIA—2017" published by Ministry of Road Transport and Highways, Government of India, shows that in 2017 most fatal accidents were those of two-wheeler riders accounting for 33% of deaths on Indian roads and 73.8% of them did not wear a helmet [1]. Also in 2018, approximately 43,600 two-wheeler riders not wearing helmets died in road accidents accounting for 28.8% of total fatal injuries in road accidents [2]. The figures mentioned here clearly indicate the importance of helmets in saving the lives of the rider. Major populous find wearing helmets uncomfortable, also there is a lack of ventilation, neck pain also storage problems are there [3, 4]. Because of these problems with existing helmets, it has become necessary to find smart alternatives. The steps shown in Fig. 1 can be followed to finalize the concept.

2 Problem Definition

Defining the problem statement accurately is the initial stage of the conceptual design process. In this case, the existing helmet model has many limitations viz. uneasiness, lack of ventilation, heavyweight hence causing neck pain, limited field of vision, hearing ability, storage, carriage problem, etc. The majority of bike riders do not opt

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S. Kumar et al. (eds.), *Recent Advances in Manufacturing Modelling and Optimization*,
Lecture Notes in Mechanical Engineering,
https://doi.org/10.1007/978-981-16-9952-8_29

Lecture Notes in Mechanical Engineering

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P. Sathiya
D. Palanisamy *Editors*

Recent Advances in Materials and Modern Manufacturing

Select Proceedings of ICAMMM 2021

Springer

Investigative Study on Triplex Tube Heat Exchanger with Stearic Acid as Phase Change Material

Pitambar Subhash Gadhave and Chandrakant L. Prabhune

Abstract Although there are many types of thermal energy storages; thermal energy storage with phase change materials (PCM) gives better efficiency due to its high-energy storage capacity and remove the discrepancy between the demand and provide of energy. This study experimentally investigates the charging and discharging process with the use of triplex tube heat exchange device with stearic acid ($C_{18}H_{36}O_2$) as phase change material. The experimentation examined the PCM melting and solidification process with steady inlet temperature of heat transfer fluid. Also, it investigates the effect of mass flow on charging and discharging. The heat transfer rates as well as average effectiveness with duration of phase change process were compared. The result showed that, for both mass flow of 0.33 kg/s and 0.43 kg/s rate of heat transfer during melting and freezing initially declines, it stays stable. It is observed that due to effect of free convection, effectiveness is much higher during the charging than that during discharging process. The average effectiveness is 80% for charging and 70% for discharging.

Keywords Triplex tube heat exchanger · Phase change material · Melting · Solidification · Stearic acid

1 Introduction

The latent heat storage materials with thermal energy storage system bridge the gap between energy demand and supply of energy. Thermal energy storage is broadly classified into three groups; sensible heat storage, latent heat thermal energy storage and thermo-chemical energy storage [1]. In sensible heat storage (SHS), the heat energy stored is dependent on the specific heat of material, quantity of material used and its temperature. In this type, heat stored within the sort of internal energy by raising the temperature of a medium with high-energy capacity without change of phase. The main disadvantages of storage of sensible energy are; it requires a bigger

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I. A. Palani et al. (eds.), *Recent Advances in Materials and Modern Manufacturing*,
Lecture Notes in Mechanical Engineering,
https://doi.org/10.1007/978-981-19-0244-4_9

EasyChair Preprint

№ 5119

Experimental and FEA of Optimized Existing Lower Control Arm

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March 9, 2021

Experimental and FEA of optimized existing lower control arm

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Abstract : The lower control arm is an interesting kind of autonomous suspension utilized in four wheel vehicles. During the genuine working condition, the most extreme load is moved from upper arm to the lower control arm which makes plausibility of failure in the arm. Henceforth it is fundamental to concentrate on the stress investigation of lower control arm to improve and alter the current design. A lower control arm is a significant part utilized in a suspension arrangement of a vehicle. So, this arm execution a significant job in dealing with the movement of the wheel during knock, turning, and breaking. In present research design of lower control arm is done in CATIA software. ANSYS19 software was also used for analyze the structural strength and optimize the parts weight along with modal analysis to determine natural frequency with mode shape and validate the results with FFT technique. The target of the new design was 8% weight reduction from the existing part fabricated using steel material. Testing and validation of new design using FFT analyzer is done and it is found that average percentage error in experimental and theoretical analysis of natural frequency is around 0.92%.
Keywords—LCA, FEA, Modal Analysis, Impact Hammer Test

I. INTRODUCTION

Electric-versatility, CO_2 emanation limits, fuel, an Earth-wide temperature boost and vitality costs are a portion of the variables driving lightweight car structure. Lightweight structure requires appropriate, financial assembling advances notwithstanding the utilization of lightweight materials. Thus, it is a test to car producer to create the lightweight vehicle without trading off their presentation. Weight decrease empowers the producer to build up a similar vehicle execution with a littler motor, and such a littler motor empowers the utilization of a littler transmission and fuel tank. With these expanding influences, it is assessed that 10% of vehicle weight decrease brings about 8–10% of mileage improvement. The suspension framework caries the vehicle body and transmit all powers between the body and the street without transmitting to the driver and travellers. The suspension arrangement of a vehicle is utilized to help its weight during fluctuating street conditions. The suspension framework is made of a few sections and parts. These incorporate the front and back. In the car business, dealing with characteristics of vehicle is a significant issue. These characteristics are extraordinarily influenced by the suspension framework. The suspended segment of the vehicle is connected to the wheels. To pad the effect of street inconsistencies suspension arm is associated. Suspension arm is the principle part in car suspension framework. It conveys all the various burdens made because of sporadic streets. There are different kinds of suspensions like wishbone or twofold wishbone suspensions. There are loads of research works which comprise of suspension framework, various kinds of suspension framework, upper and lower control arm. The lower control arm is exposed to numerous heaps because of variety in net weight and effects because of vacillation of street surface and extra powers. The un-sprung mass is the mass of the suspension segments which is legitimately associated with them, instead of upheld by the suspension. High un-sprung weight intensifies issues like wheel control, ride quality and commotion. Un-sprung weight incorporates the mass of parts, for example, the wheel axles, wheel course, wheel centre points, springs, safeguards, and Lower Control Arm. The lower control arm gets more consideration by

numerous explores like examination dynamic investigations of the engine vehicle suspension framework utilizing the point-joint facilitates detailing.

Song and et al.(2010) suggested surrogate models which were Simulation-based used for a different applications of automotive industry. They have done the FEM analysis; both of the Kriging model and response surface model (RSM) were used for optimization of upper control arm. The weight of the upper control arm was considered as the design objective, with the allowable maximum von Mises stress as the constraint objective. The optimization results were obtained by using RSM and KRG were confirmed by FEM analysis. The authors also carried out fatigue analysis for verification of the final design durability. Whereas Dattatray Kothawale and et al.(2013) have done finite element analysis for MacPherson type suspension system A Lower control arm (LCA) of 4Wheel vehicle. The main function of the A control arm was to manage the motion of the wheels & keep it relative to the body of the vehicle. The CAD Model was prepared by using PRO-E Software & finite element analysis by using Ansys software. Various dynamic loads like road bump, kerb strike, braking, cornering & acceleration load case were studied in dtail. By applying all this forces in X, Y and Z directions non-linear static analysis was performed using Ansys software [4]. Balasaheb Gadade and et al.(2015)carried out the work which was mainly focused on the finite element based stress analysis of A – Type A suspension arm. The main objective of this study was to calculate working life of the component under static loading. Actual model was manufacture as per Design by using AISI 1040 material. The finite element modeling and analysis were performed by using HYPERMESH software. A simple design approach was used to calculate effect of stresses on A – Type A suspension arm element under static loading condition. The experimental work included validation of the FEA results with actual testing of the model under stress [6]. Further Sridharan and et al.(20016) worked on modeling and performing structural analysis of a Lower Control Arm (LCA) used in the front suspension system, made up of sheet metal. LCA was modeled in Pro-E software for the given specification. For the analysis of the LCA, Computer Aided Engineering (CAE) software was used. Dynamic load acting on the lower was considered for study purpose; also buckling load analysis was done. First finite element analysis was performed to calculate the buckling strength, of a control arm. After getting the final result of finite element analysis optimization has been done by using design of experiment method (DOE). Taguchi's DOE was used to optimize the number of experiments. By reducing thickness of the sheet metal and by suggesting the suitable material the production cost could be reduced. Hence it resulted in cost saving and improved material quality of the product.[3] Viqaruddina and et al.(2017) have designed the system by topology optimization for compare the base run analysis and optimized analysis. Meshing was carried out by using 10 nodes tetrahedral element in Hyper Mesh & topology optimization was carried out for the given design space. The topology optimization given the idea of optimum material layout based on load & boundary conditions. Using optimum material layout, the component geometry is finalized by keeping the strength of component constant & 30% reduction in weight [2]. Also Seifried and et al.(2018) have aimed to reduce the mass of flexible members without deteriorating the accuracy of the system. The structural optimization based on topology optimization of members of flexible multi-body system was introduced and the effects of uncertainty in the optimization process were investigated. Two sources of uncertainty, namely the model uncertainty and the un-certainty in usage were addressed. As an application example, a two-arm manipulator was used to examine and illustrate the effects of uncertainties such as different objective functions, choices of model reduction method as well as changes in the trajectory and payload of the manipulator [1]. Whereas Gunjan and et al.(2018) have quoted that the structural integrity of the suspension arm was crucial from design point of view both in dynamic as well as static loading conditions. Hence the authors presented modeling and analysis of car front suspension lower arm for studying the stress condition and to select the suitable materials for the front suspension lower arm. The main objectives of their study were to determine critical locations and strain distributions of the component. The main aim was to complete FEA of the front suspension lower arm which consist the stress optimization loadings and analysis for deformation.[5]

II. PROBLEM STATEMENT

Chassis parts are a critical part of a vehicle, leaving no room for error in the design and quality the present process relates to a computer-aided structure analysis. The design graphic display device and method, and more particularly, to a computer-aided structure analysis of A control arm is required to be done in detail. Further analysis and

designing is required. It is observed that lot of research is done on for design of the A control arm of suspension system but still scope is available for the optimization to meet the customer requirements of Lower Control Arm (LCA).

This work consists of dynamic analysis of an arm using harmonic excitation for investigation dynamic behaviors. The designing is done with computer aided design software and theoretical analysis and then actual experimentation is carried out to validate the theoretical analysis.

III. OBJECTIVES

1. To determine the problem associated due to vibration on lower control arm and preparation of cad model of existing lower control arm
2. Modeling and analysis of lower control arm for static and modal analysis using ANSYS software.
3. To perform topology optimization for weight reduction using optimization module in ANSYS to obtain optimized design.
4. To perform harmonic analysis to determine frequency response for existing and optimized design.
5. Comparison of experimental and FEA results.

V. METHODOLOGY

Step 1:- Exhaustive literature survey to study existing work and to find research gap for project work with necessary parameters which are studied in detail.
Step 2:- Finding the gap in the previous research to define the problem statement to carry out research work.
Step 3: - After deciding the components, the 3 D Model and drafting is done with the help of CAD software.
Step 4: - According to the theoretical analysis actual component is manufactured and then assembled together.
Step 5: -The experimental testing is carried out on prototype with the help of FFT analyzer and results are compared.

CATIA MODEL OF EXITING LOWER CONTROL ARM

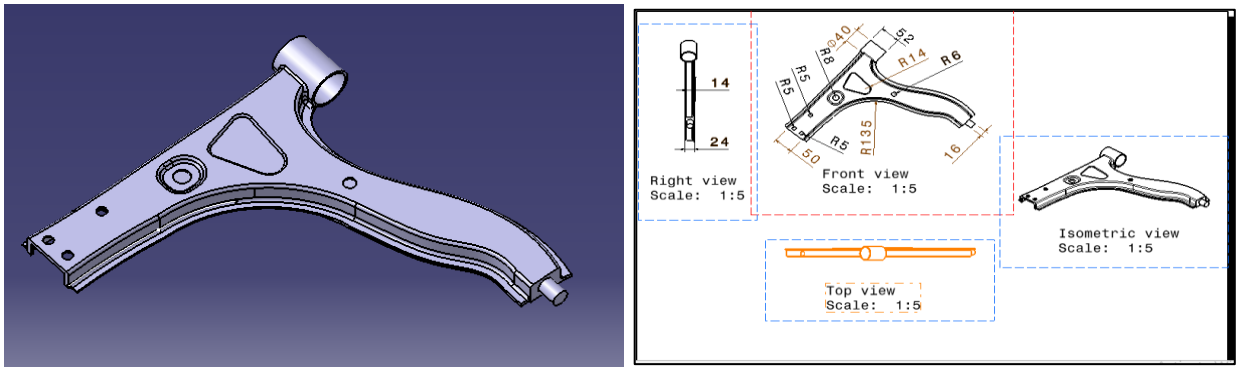


Fig. 1CATIA and drafting of lower control arm

Table1. Material Properties

Properties of Outline Row 3: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7.85E-09	tonne mm^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
5	Coefficient of Thermal Expansion	1.2E-05	C^-1
6	Isotropic Elasticity		
7	Derive from	Young's Modulus and Poiss...	
8	Young's Modulus	2E+05	MPa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+05	MPa
11	Shear Modulus	76923	MPa

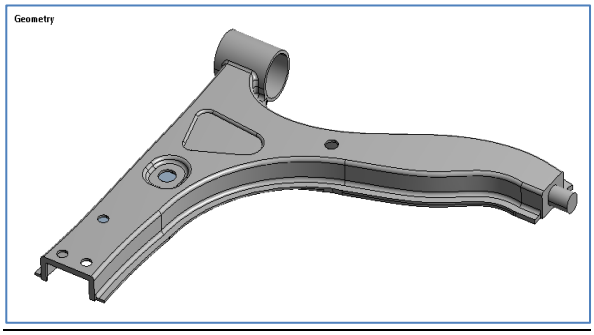


Fig.2 CATIA model imported in ANSYS

Meshing the cad model

In ANSYS meshing is performed as similar to dicretization process in FEA procedure, in which it breaks whole components in small elements and nodes. So, in analysis boundary condition equation are solved at this elements and nodes. ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient Multi-physics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it.

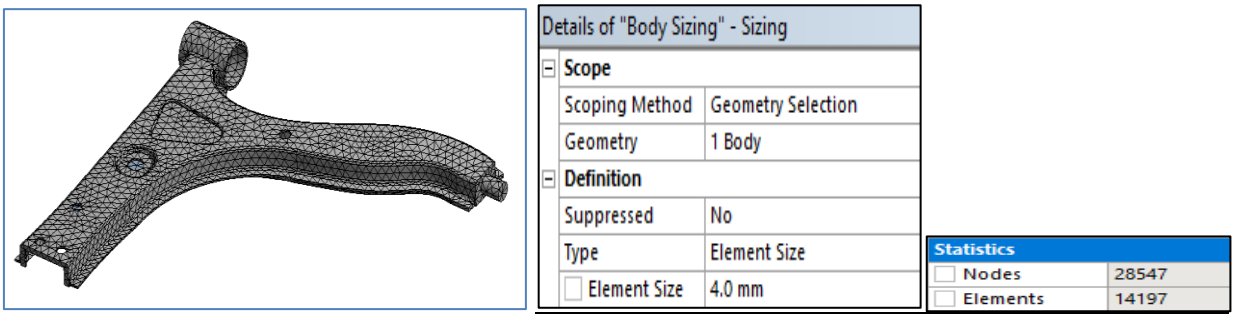
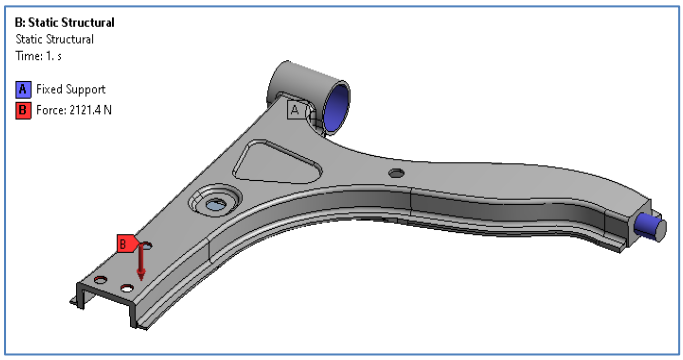


Fig.3 Details of meshing of lower control arm



VEHICLE NAME- MARUTI SUZUKI BALENO
WEIGHT – 865 KG
SO 865 X 9.81 – 8485 N
WEIGHT ON EACH WHEEL IS CONSIDERED AS 8485/4 – 2121.4 N

Fig.4 Applying boundary condition

In present FEA analysis fixed support is applied as per existing condition along with force as per vehicle specified.

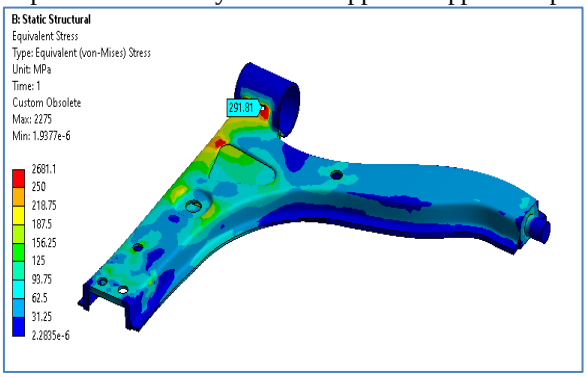


Fig.5 Equivalent stress results

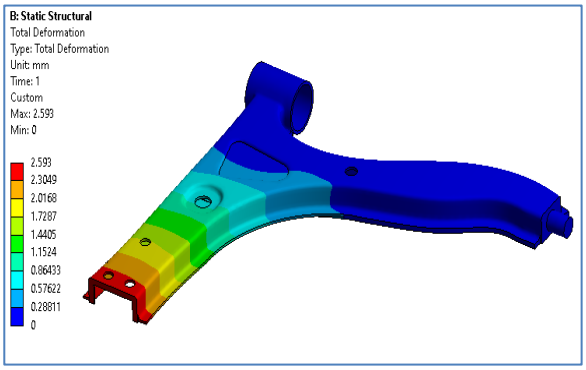


Fig.6 Total deformation results

MODAL ANALYSIS OF EXISTING SUBFRAME

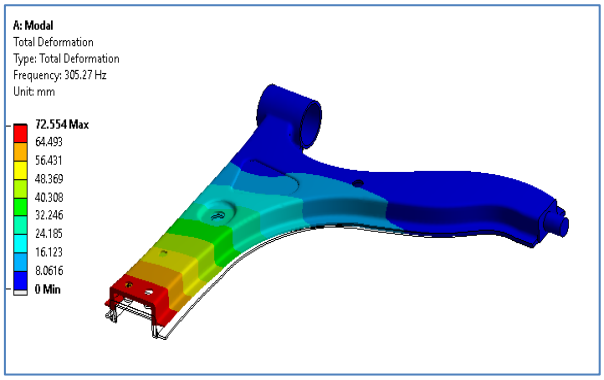


Fig.7 Mode shape 1

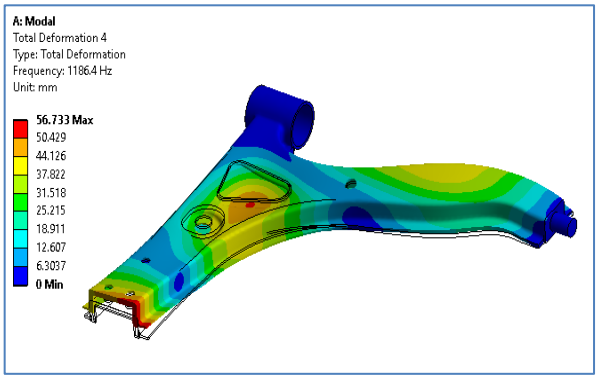


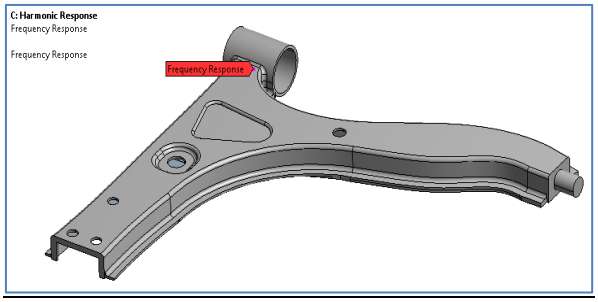
Fig.8 Mode shape 4

Table2. Tabular data of mode shape frequency

Tabular Data

	Mode	Frequency [Hz]
1	1.	305.27
2	2.	752.81
3	3.	903.67
4	4.	1186.4
5	5.	1527.8
6	6.	1649.8

Harmonic analysis of existing lower control arm



Details of "Frequency Response"

Scope	
Scoping Method	Geometry Selection
Geometry	1 Node
Spatial Resolution	Use Average
Definition	
Type	Normal Stress
Orientation	X Axis
Coordinate System	Global Coordinate System
Suppressed	No

Fig.9 Boundary condition for harmonic frequency response

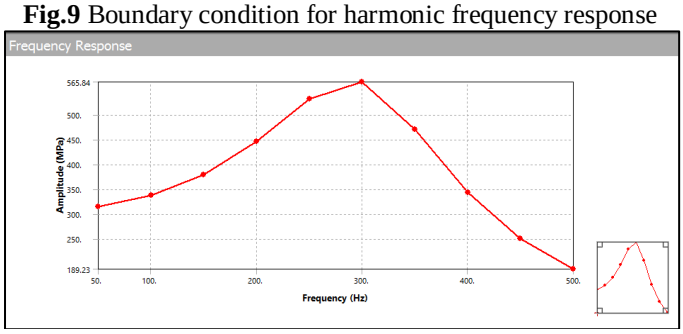
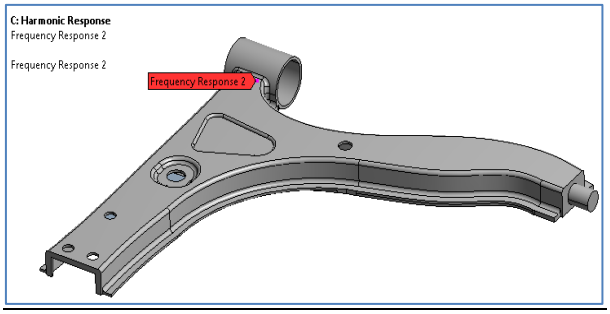


Fig.10 frequency response result along x axis



Details of "Frequency Response 2"	
Scope	
Scoping Method	Geometry Selection
Geometry	1 Node
Spatial Resolution	Use Average
Definition	
Type	Normal Stress
Orientation	Y Axis
Coordinate System	Global Coordinate System
Suppressed	No

Fig.11 Boundary condition for harmonic frequency response

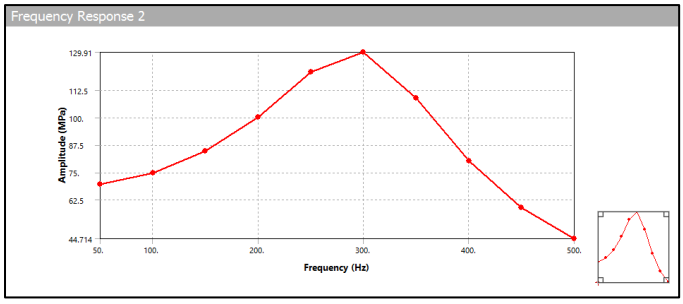


Fig.12 frequency response result along y axis

TOPOLOGY OPTIMIZATION

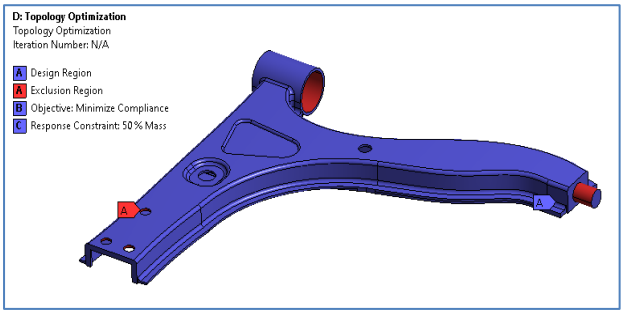


Fig.13 Boundary condition for topology optimization region

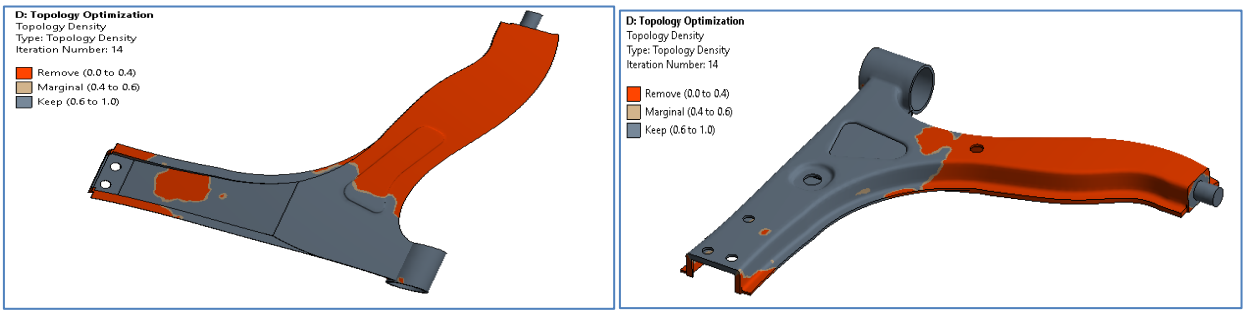


Fig.14 Topology optimized results

- Red region indicates material removal area region.

MODIFIED LOWER CONTROL ARM

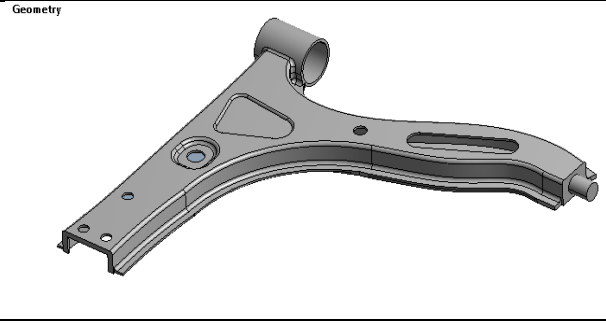


Fig.15 CATIA of modified LCA

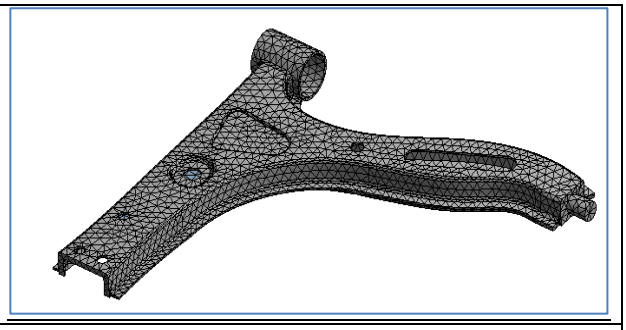


Fig.16 Details of meshing

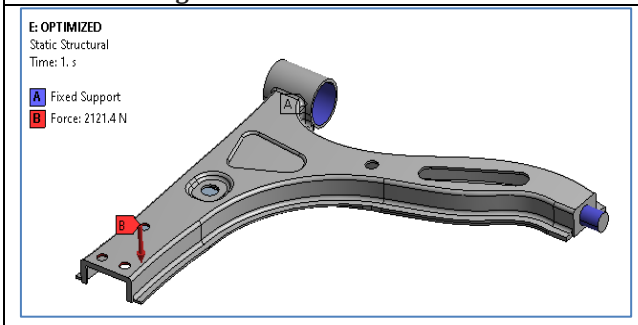


Fig.17 Boundary condition for modified LCA

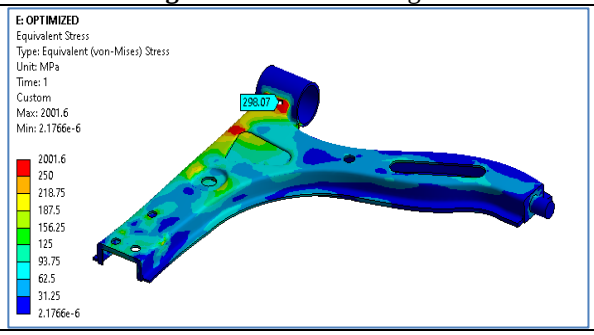


Fig.18 Equivalent stress results

With the modified design of the lower arm again analysis is carried out by applying the similar loading boundary conditions as applied for the existing system and results are checked.

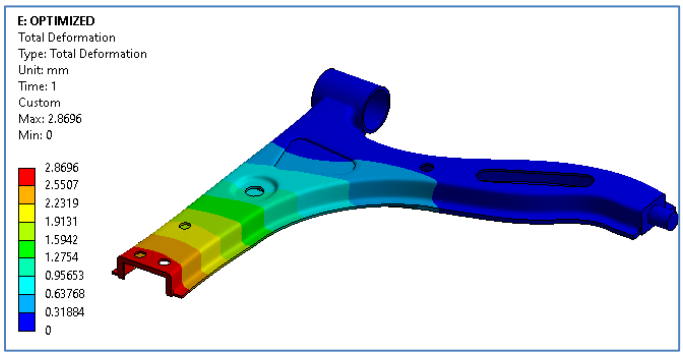
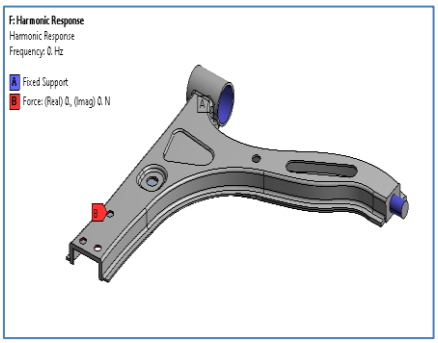
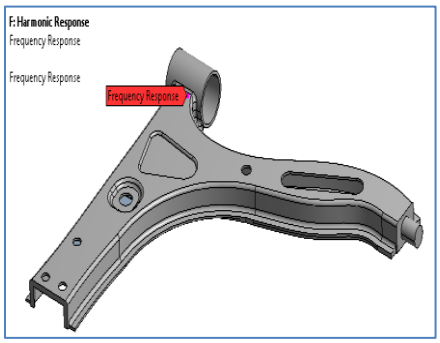


Fig.19 Total deformation results

Harmonic response for optimized lower control arm





Details of "Frequency Response"	
Scope	
Scoping Method	Geometry Selection
Geometry	1 Node
Spatial Resolution	Use Average
Definition	
Type	Normal Stress
Orientation	X Axis
Coordinate System	Global Coordinate System
Suppressed	No

Fig.20 Boundary condition for Optimized lower control arm for harmonic response surface along x axis

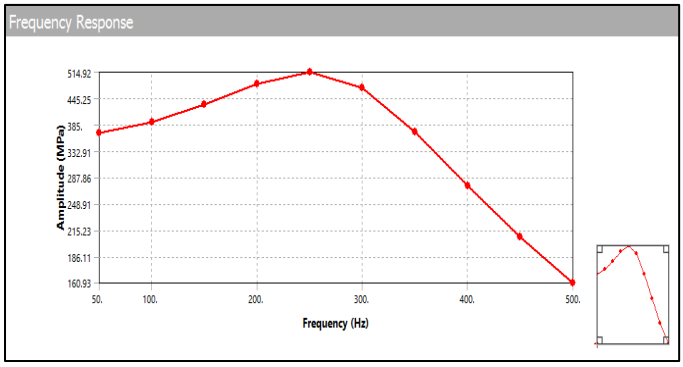
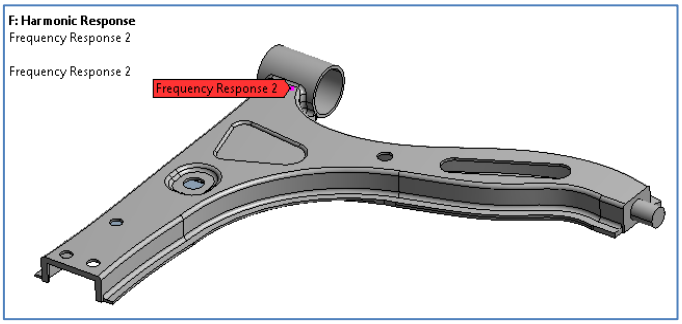


Fig.21 Frequency response result for optimized lower control arm along **x** axis



Details of "Frequency Response 2"	
Scope	
Scoping Method	Geometry Selection
Geometry	1 Node
Spatial Resolution	Use Average
Definition	
Type	Normal Stress
Orientation	Y Axis
Coordinate System	Global Coordinate System
Suppressed	No

Fig.22 Boundary condition for Optimized lower control arm for harmonic response surface along **y** axis

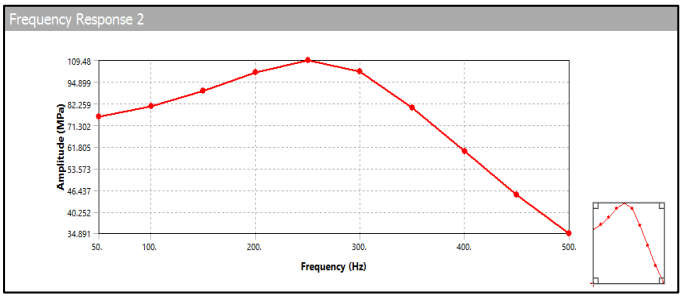


Fig.23 Frequency response result for optimized lower control arm along **y** axis

It is observed from harmonic analysis that amplitude along **x** and **y** axis in optimized design has decreased by 4% as compared to original design.

Modal analysis of optimized lower control arm

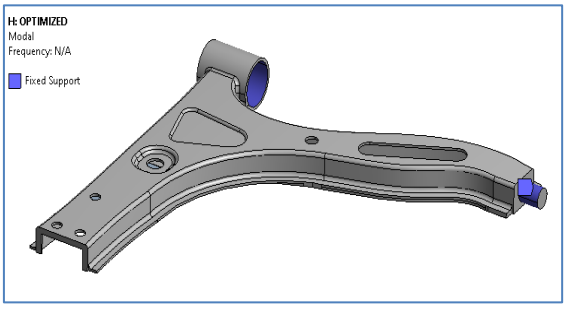


Fig.24 Boundary condition for modal analysis

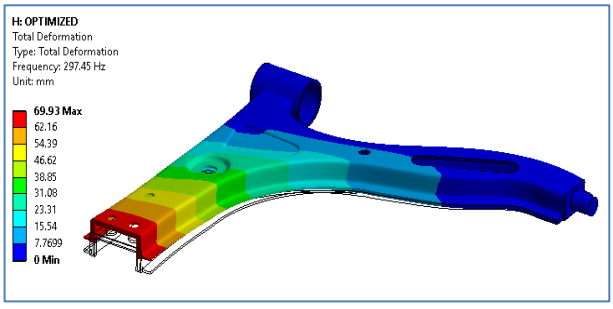


Fig.25 Mode shape 1

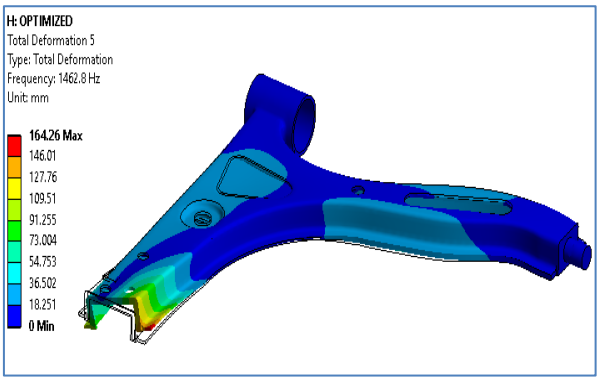


Fig.26 Mode shape 5

Table 3 . Tabular data of natural frequency with respective mode shapes

Tabular Data		
	Mode	Frequency [Hz]
1	1.	297.45
2	2.	704.17
3	3.	871.46
4	4.	1175.9
5	5.	1462.8

EXPERIMENTAL TESTING

Fast Fourier Transform

FFTs were first discussed by Cooley and Tukey (1965), although Gauss had actually described the critical factorization step as early as 1805 (Bergland 1969, Strang 1993). A discrete Fourier transform can be computed using an FFT by means of the Danielson-Lanczos lemma if the number of points N is a power of two. If the number of points N is not a power of two, a transform can be performed on sets of points corresponding to the prime factors of N which is slightly degraded in speed. An efficient real Fourier transform algorithm or a fast Hartley transform (Bracewell 1999) gives a further increase in speed by approximately a factor of two. Base-4 and base-8 fast Fourier transforms use optimized code, and can be 20-30% faster than base-2 fast Fourier transforms. Prime factorization is slow when the factors are large, but discrete Fourier transforms can be made fast for N=2, 3, 4, 5, 7, 8, 11, 13, and 16 using the Winograd transform algorithm.

The experimental validation is done by using FFT (Fast Fourier Transform) analyzer. The FFT spectrum analyzer samples the input signal, computes the magnitude of its sine and cosine components, and displays the spectrum of these measured frequency components. The advantage of this technique is its speed. Because FFT spectrum analyzers measure all frequency components at the same time, the technique offers the possibility of being hundreds of times faster than traditional analog spectrum analyzers.

Fourier analysis of a periodic function refers to the extraction of the series of sines and cosines which when superimposed will reproduce the function. This analysis can be expressed as a Fourier series. The fast Fourier transform is a mathematical method for transforming a function of time into a function of frequency. Sometimes it is described as transforming from the time domain to the frequency domain. It is very useful for analysis of time-dependent phenomena.

Impact Hammer Test

Impact excitation is one of the most common methods used for experimental modal testing. Hammer impacts produce a broad banded excitation signal ideal for modal testing with a minimal amount of equipment and set up. Furthermore, it is versatile, mobile and produces reliable results. Although it has limitations with respect to precise positioning and force level control, overall its advantages greatly outweigh its disadvantages making it extremely attractive and effective for many modal testing situations.

The use of impulse testing with FFT signal processing methods presents data acquisition conditions which must be considered to ensure that accurate spectral functions are estimated. Problems stem from the availability of only a finite duration sample of the input and output signals. When a structure is lightly damped the response to the hammer impact may be sufficiently long that it is impractical to capture the entire signal. The truncation effect manifests itself in terms of a spectral bias error having the potential to adversely affect the estimated spectra. The signal truncation problem is further compounded in practice by the computational and hardware constraints of the FFT processing equipment. Typically the equipment has a limited number of data capture lengths or frequency ranges which are available for an operator to select. Normally a user is more concerned with useable analysis

frequencies and less with the data capture length. Therefore, it is conceivable that an inappropriate data capture duration could be used which truncates the vibration signal and introduces errors in the estimated spectra. To suppress the truncation a common practice is to artificially force: it to decay within the data capture window [1,2,3]. This artificial reduction is obtained by multiplying the slowly decaying vibration signal by an exponential function. However, the application of the exponential window must be considered carefully since it may also adversely affect the estimated spectra.

A phenomenon commonly encountered during impact testing is the so called "double hit". The "double hit" applies two impulses to the structure, one initially and one time delayed. Both the temporal and spectral characteristics of the "double hit" input and output are significantly different than a "single hit". The input force spectrum for the "double hit" no longer has the wide band constant type characteristics of a single hit. The purpose of this paper is to examine the use of impact vibration testing in relation to the constraints imposed by typical FFT' signal processing techniques. The characteristics of the impact testing procedure are examined with analytical time and spectral functions developed for an idealized test: a single degree of-freedom system excited by a half sine impact force. Once an understanding of the fundamental characteristics is developed it is applied to examine the specific situations encountered in structural impact testing. The relationship of the system's parameters with respect to data capture requirements is evaluated. The effects of exponential windowing are developed to examine the effects on the estimated spectra and modal parameters. Finally, the "double hit" phenomena is examined by combining the results from the single degree-of-freedom system excited by two impulses, one of which is time delayed. The results from these related studies are combined to provide insight into data acquisition guidelines for structural impact testing.

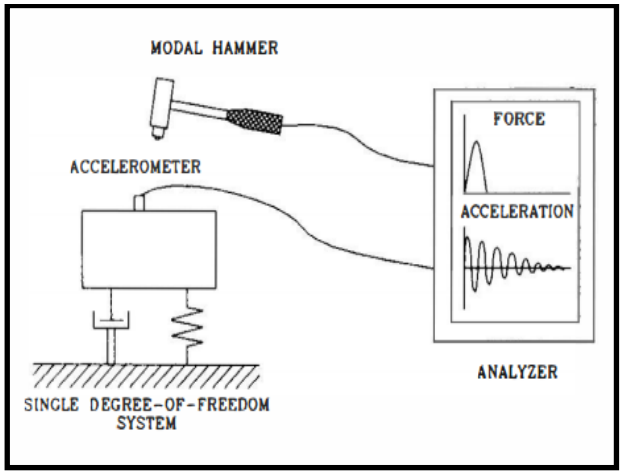


Fig 27: FFT construction

Fig.28 Experimental setup of FFT

EXPERMENTAL PROCEDURE

- Initially fixture is designed according to existing boundary condition as per FEA results.
- FFT analyzer consists of impact hammer, accelerometer, data acquisition system in which each supply is applied to DAS and laptop with DEWSOFT software to view FFT plot.
- Accelerometer is mounted at surface as per high deformation observed in FEA results along with initial impact of hammer are placed for certain excitation to determine frequency of respective mode shapes.
- After impact FFT plot are observed on laptop and comparison of FEA and experimental results are analyzed.
- Five sets of experiments are carried out with the help of new modified lower arm system and results are compared. For sample demonstration a single frequency response on FFT analyzer is shown below.

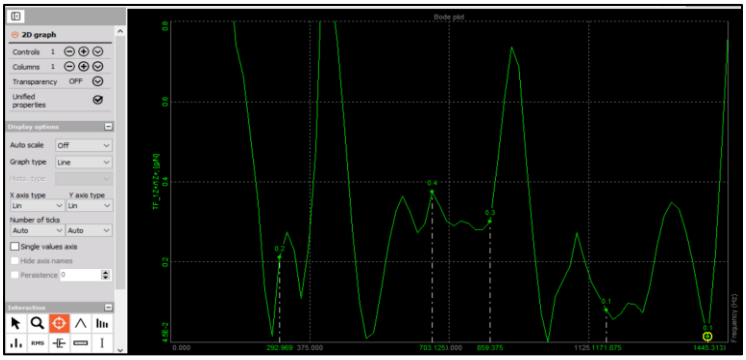


Fig.29 FFT plot of optimized lower control arm

Table 4 Comparison of modified muffler FEA and FFT results

Natural frequency (Hz) MODE SHAPE	FEA	Experimental	Percentage error in Experimental and theoretical analysis (%)
1	297.45	292.96	1.51
2	704.17	703.12	0.15
3	871.46	859.37	1.39
4	1175.9	1171.87	0.34
5	1462.8	1445.30	1.20
Average percentage error in Experimental and theoretical analysis			**0.92**

Hence it is confirmed that the modified design of the lower control arm is safe and has added advantage that it is reduced in the weight by 8% than the existing lower are system used in the market.

CONCLUSION

- In present research existing lower control is redesigned with the help of topology optimization algorithm in ANSYS.
- Weight optimization of 7.8 % is observed as initial weight is around 1.79 kg and reduced weight is around 1.65 kg.
- It is observed that in harmonic analysis frequency response along x and y axis has been reduced in optimized design compared to existing design.
- Experimental FFT analysis natural frequencies are nearly identical with numerically obtained analysis with an average error of 0.92%.
- Hence it is confirmed that modified design of the lower control arm is safe and validated with experimental results.

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INDEX

3.3.2 Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during a year 2021-22

Sr. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Name of the conference
1	Prof. Dipali Pawar	Big Data Analytics	NA	NA	NA
2	Prof. Dipali Pawar	Data Structure & Algorithm	NA	NA	NA
3	Prof. Dr. Neeta Thune	Fundamentals of Data Structures	NA	NA	NA

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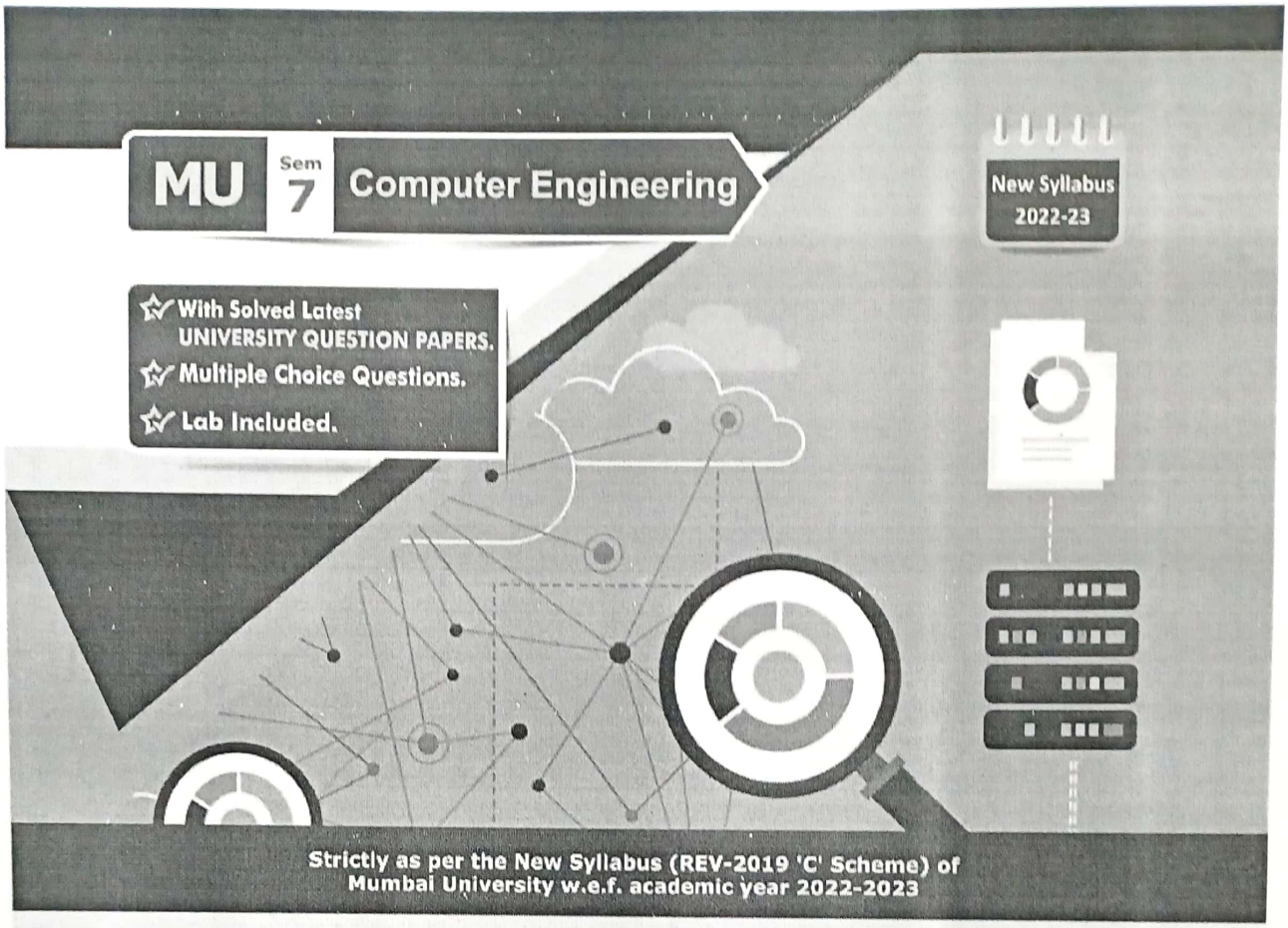

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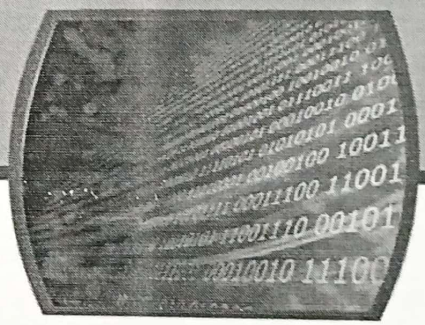

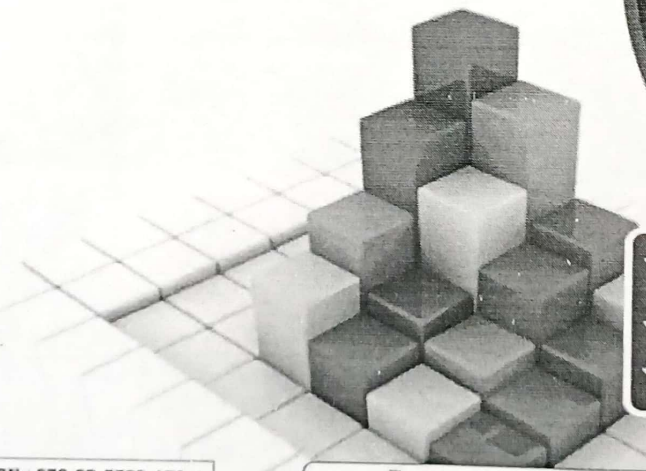

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Published & Printed By :

NITYA PUBLICATIONS

Nitya Publications, Bhopal MP India
Web: www.nityapublications.com
Email : info@nityapublications.com
Mob. : +91-9009291840

MRP Rs.399.00

ISBN 978-93-93694-12-6

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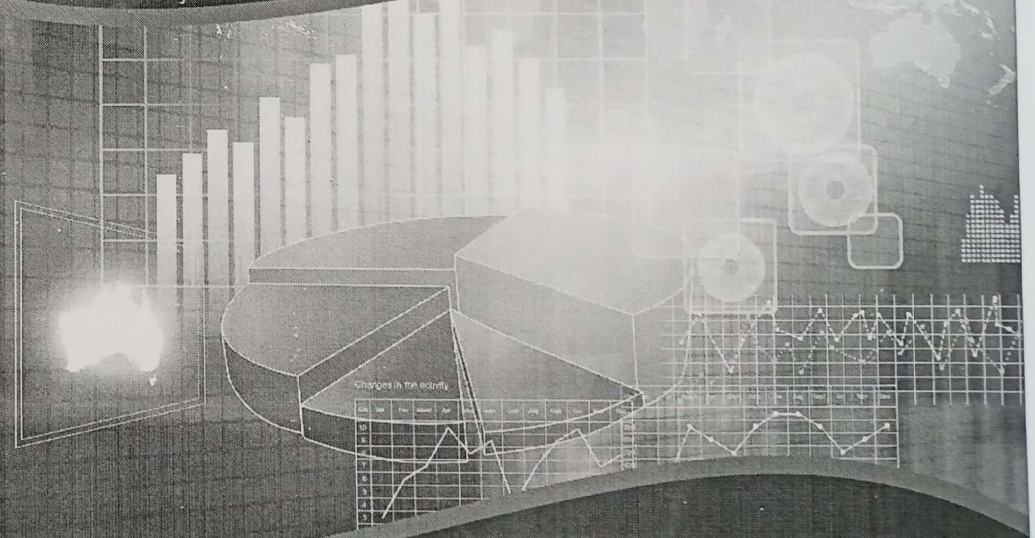

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