Temporary Registration No. : TPN / 100899

सत्यमेव जयते
Ministry of Science & Technology
Government of India

# Project Proposal On

*"Structural integrity and Material selection for 3D printed prosthetic sockets  Numerical and Experimental Analysis for paediatric applications"*

## Submitted to

**Division :**SEED

**Programme or Scheme :** Technology Interventions for Disabled and Elderly (TIDE)

## Submitted by

**Project Investigator:**

Dr. B Sridhar Babu

MALLAREDDY ENGINEERING COLLEGE (A)-Secunderabad

# Part 1 : General Information

## General Information:

**Name of the Institute/University/Organisation submitting the Project Proposal :**

MALLAREDDY ENGINEERING COLLEGE (A)

| | |
|---|---|
| **State** | Telangana |
| **Principal Investigrator Name:** | Dr. B Sridhar Babu |
| **Category:** | OBC |
| **Type of the Institue :** | Academic Institutions (Private) |
| **Project Title :** | Structural integrity and Material selection for 3D printed prosthetic sockets Numerical and Experimental Analysis for paediatric applications |
| **Division :** | SEED |
| **Programme Or Scheme :** | Technology Interventions for Disabled and Elderly (TIDE) |
| **Academic Area :** | Mechanical Engineering, |
| **Application Area :** | Basic Science, |
| **Goverment National Initiative :** | Not Applicable, |
| **Type of Proposal :** | Proposal Against Call |
| **Project Duration :** | 2 Years |
| **Proposal Submit Date :** | 30/09/2023 |
| **Project Keywords :** | prosthetic limb, 3D printing, Manufacturing, socket, Design, Finite element analysis , |

**Project Summary :**

Prosthetic devices playing major role in bringing the happiness in the lives of people those who are seriously suffering with disabilities and making them more independent and fulfilling lives. However there is a much scope in the improvement of prosthetic devices, and in the coming years, prosthetic devices holds great promise.
In the recent years rapid developments has been taken place in the prosthetics, one of the great significant change is usage of advanced materials and additive manufacturing technology in manufacturing of prosthetic devices. Advanced materials like polymers, metal matrix composite materials enabled the devices more lighter, durable and more comfortable for the user. Additionally, artificial intelligence, sensor technology and deep learning have made possible to create smart prosthetic devices, these devices can respond to the user's body movements, muscle movements and also provide sensory feedback. In addition, important advancements have been implemented in integrating prosthetic devices with the user's nervous system and also important progress has been made in the development of brain devices interfaces that can interpret signals from the user's brain and translate them into the prosthetic movements. This technology very useful to the people with spinal card injuries or other conditions that limit the mobility.
However, despite of these advancements, still there are issues or problems associated with prosthetic devices one of the most significant issues is affordability. Prosthetic devices, especially the best ones, can be expensive making them inaccessible to much number of disabled persons who would benefit from them. Another important issue about prosthetic devices is longevity. Many of these devices are subject to constant wear and tear and their function often relies on the materials used in their construction. However, despite of using advanced materials like polymers, there are still issues regarding their, long term reliability, discomfort, and skin irritation for the end user. So Continuous research development in the area of prosthetic device materials science are very much important to address these challenges and ensure that these prosthetic devices very much accessible and effective for all individuals in need

In a prosthetic leg, Socket is the important part that joins the residual limb of the end user with the rest of the prosthetic limb. Young children grow rapidly, which can lead to problems in accommodating the prosthetic socket to the residual limb of the young children due to the size and volume changes. This can increase the rehabilitation cost significantly. Now a day's artificial manufacturing technology most regularly used in the manufacturing of 3D printed socket for affordability, so for a better mechanical performance of prosthetic socket a proper design and analysis is required.

Generally the prosthetic sockets are subjected to the combination of bending and compressive loads. These types of loads are due to the posture and weight of the user. So structural integrity of the prosthetic socket is very essential for examining the safety of the prosthesis. Many investigations have been done for adult users but there is no investigations on the young children prosthetics in the literature.
So this project mainly focuses on selection of material and structural integrity of the 3D printed pediatric prosthetic socket using experimental and numerical analysis.

The main objectives of the projects are
1.Design of the prosthetic socket for young children
2.Experimental and numerical Analysis of structural integrity of the socket
3.Proper Material and design parameter selection for prosthetic socket for young children
4.Fabrication of prosthetic socket for young children

Methodology

This project implementation mainly covers four phases

1.Design of prosthetic socket for a 15 year old male's residuum using CAD
2.Manufacturing the prosthetic socket using 3D printing technology with different materials
i. PLA polylactic acid--- Tensile strength 45MPa Elastic Modulus 2000MPa,
ii. ABSAcrylonitrile butadiene styrene----Tensile strength 38MPa Elastic Modulus 1310MPa,
iii. Polycarbonate PC--- Tensile strength 36MPa Elastic Modulus 1000MPa,

3.Investigation of the structural integrity of the socket by conducting principal strength test at static and cyclic loads using ANSYS software and also by performing mechanical tests experimentally.
4.Analysis of PLA polylactic acid, ABSAcrylonitrile butadiene styrene and Polycarbonate PC 3D printed socket materials performance at static and cyclic loads.

Based on the results Selection of proper Material and design parameter selection for prosthetic socket for young children.

## Part 2: Particulars of Investigators

### Principal Investigator:

**1. Name:** Dr. B Sridhar Babu

| | |
|---|---|
| **Gender:** | Male |
| **Date of Birth:** | 08/05/1974 |
| **Designation :** | Professor |
| **Department:** | Mechanical Engineering |
| **Institute/University:** | MALLAREDDY ENGINEERING COLLEGE (A) |
| **State:** | Telangana |
| **District:** | Ranga Reddy |
| **City/Place:** | Secunderabad |
| **Address:** | maisammaguda, dhulapally post-500100 |
| **Pin:** | 500100 |
| **Communication Email:** | bsridhar8477@gmail.com |
| **Alternate Email:** | |
| **Mobile:** | 9247969234 |
| **Phone:** | |
| **Fax:** | |
| **Category:** | OBC |

## Co-Investigator:

| | |
|---|---|
| **1. Name:** | Dr. ISNVRPrashanth |
| **Gender:** | Male |
| **Date of Birth:** | 10/12/1977 |
| **Designation :** | Associate Professor |
| **Department:** | Mechanical Engineering |
| **Institute/University:** | MALLA REDDY ENGINEERING COLLEGE(AUTONOMOUS) |
| **State:** | Telangana |

| | |
|---|---|
| **District:** | Hyderabad |
| **City/Place:** | Hyrabad |
| **Address:** | Malla Reddy engineering college<br>Maisamma guda, gulapally, Hyderabad |
| **Pin:** | 500100 |
| **Communication Email:** | prasanth5109@gmail.com |
| **Alternate Email:** | |
| **Mobile:** | 9963244299 |
| **Phone:** | |
| **Fax:** | |
| **Category:** | General |

# Part 3: Suggested Refrees

## Suggested Refrees:

| | |
|---|---|
| **1. Name:** | Anjaneya Prasad |
| **Mobile:** | |
| **Designation :** | Professor |
| **Email:** | baprasadjntu@gmail.com |
| **Institute/University:** | JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD |
| **Address:** | Directorate of Research & Development<br>Jawaharlal Nehru Technological University Hyderabad<br>Kukatpally, Hyderabad, Telangana. Pin-500085 |
| **Academic Area:** | Mechanical Engineering, |
| **Application Area:** | Basic Science, |
| **State:** | Telangana |
| **District:** | Ranga Reddy |
| **City:** | Hyderabad |

**Address:**

**Pin Code:**

**2. Name:** Chandrashekar

**Mobile:**

**Designation :** Professor

**Email:** hodmech.vignanhyd@gmail.com

**Institute/University:** VIGNAN INSTITUTE OF TECHNOLOGY AND SCIENCE

**Address:** Deshmukhi, Pochampally, YadadriBhuvanagiri, Telangana, India

**Academic Area:** Mechanical Engineering,

**Application Area:** Basic Science,

**State:** Telangana

**District:** Hyderabad

**City:** Hyderabad

**Address:**

**Pin Code:**

# Part 4: Financial Details

## Financial Details:

### A. Non - Recurring

Equipment

| S. | Equipments | Qty. | Justification | 1 Year | 2 Year | Total |
|---|---|---|---|---|---|---|
| 1 . | 3D printer | 1 | Manufacturing of prosthetic socket | 0 | 450000 | 450000 |
| 2 . | Ansys software | 1 | Software used to analyze the structural integrity of socket | 350000 | 0 | 350000 |
| 3 . | Pro E software | 1 | Used for prosthetic socket design | 250000 | 0 | 250000 |
| 4 . | UTM | 1 | Test the strength of materials and socket | 0 | 950000 | 950000 |
| | | | **Total** | **600000** | **1400000** | **2000000** |

### B. Recurring

Project Staff

| S. | Project Staff | No. | Justification | 1 Year | 2 Year | Total |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 . | Project Assistant | 1 | Project Assistant<br>Dr S Venugopal Rao<br>PhD<br>Hyderabad | 240000 | 240000 | 480000 |
| | | | **Total** | **240000** | **240000** | **480000** |

Consumables

| S. | Items | Qty. | Justification | 1 Year | 2 Year | Total |
|---|---|---|---|---|---|---|
| 1 . | Acrylonitrile butadiene styrene | 10 | material for 3D printing | 0 | 30000 | 30000 |
| 2 . | Poly corbonate material | 10 | 3D Printing material | 0 | 40000 | 40000 |
| 3 . | polylactic acid | 10 | 3D printing material | 0 | 30000 | 30000 |
| | | | **Total** | **0** | **100000** | **100000** |

Contingency

| S. | Description | Justification | 1 Year | 2 Year | Total |
|---|---|---|---|---|---|
| 1 . | unforeseen expenditure | unexpected expenditure | 10000 | 10000 | 20000 |
| | | **Total** | **10000** | **10000** | **20000** |

Travel

| S. | Description | Justification | 1 Year | 2 Year | Total |
|---|---|---|---|---|---|
| 1 . | Project implementation | meeting vendors | 20000 | 20000 | 40000 |
| 2 . | travel expenses | to attend DST meetings and meeting ollaborator | 10000 | 10000 | 20000 |
| | | **Total** | **30000** | **30000** | **60000** |

Overhead

| S. | Description | Justification | 1 Year | 2 Year | Total |
|---|---|---|---|---|---|
| 1 . | Institutional overheads | institutional overheads | 10000 | 10000 | 20000 |
| | | **Total** | **10000** | **10000** | **20000** |

Any Other Recurring

| S. | Description | Justification | 1 Year | 2 Year | Total |
|---|---|---|---|---|---|
| 1 . | Fabriction material | Fabrication of supporting system for UTM machine | 0 | 20000 | 20000 |
| | | **Total** | **0** | **20000** | **20000** |

# Budget Head Summary in (INR)

| Budget Head | Year-1 | Year-2 | Total |
|---|---|---|---|
| **1- Non-Recurring** | | | |
| Equipment | 600000 | 1400000 | **2000000** |
| Subtotal (Capital) | 600000 | 1400000 | **2000000** |
| **2- Recurring** | | | |
| Project Staff | 240000 | 240000 | **480000** |
| Consumables | 0 | 100000 | **100000** |
| Contingency | 10000 | 10000 | **20000** |
| Travel | 30000 | 30000 | **60000** |
| Overhead | 10000 | 10000 | **20000** |
| Any Other Recurring | 0 | 20000 | **20000** |
| Subtotal (General) | 290000 | 410000 | **700000** |
| Total Project Cost (Capital + General) | **890000** | **1810000** | **2700000** |

# Part 5: PFMS Details

## PFMS Unique Code Available: Yes

**PFMS Unique Code :** TLML00000156

# Part 6: Current Ongoing Project

## Current Ongoing Project: NA

# List of Uploaded Documents:-

1. Complete Project proposal
2. Biodata
3. Certificate from PI
4. Conflict of interest
5. Endorsement from head of Institute
6. Quotation for Equipments

## PART I. EXECUTIVE SUMMARY

1.Title of the Project: **Structural integrity and Material selection for 3D printed prosthetic sockets : Numerical and Experimental Analysis for paediatric applications**

2. Category of the Project:

| *Sl. No.* | *Category* | *Please tick* |
|---|---|---|
| 1. | Developing at least a *Technology Readiness Level (TRL) – 5 AT product | |
| 2. | Enhancing Technology Readiness Level through Large-Scale Field Trials of products (which are at TRL 5 – Technology validation in relevant environment) | √ |
| 3. | Scaling up of products in collaboration with industry partners | |

3. Project Proposal submitted for addressing which target groups:

| *Sl. No.* | *Target Groups* | *Please Tick* |
|---|---|---|
| 1. | Elderly | |
| 2. | Persons with Disability (PwD) | √ |

3.1 In case the project proposal is submitted under disability category, please give the following details

| *Area*[1] / *Disability* | *Early Diagnosis* | *Independent Living* | *Education* | *Livelihood* |
|---|---|---|---|---|
| Visual | | | | |
| Locomotor | | √ | | |
| Intellectual | | | | |
| Hearing | | | | |
| Speech | | | | |
| Multiple | | | | |
| Any other (please specify) | | | | |

3.2 Have you done any preliminary work with respect to the selected target groups (Persons with Disabilities). If yes, please give the following details (please refer to Annexure – D on page No. 24-25 for description)

| Type of Disability | [1]Consulted PwD? | [2]Consulted Experts | [3]Nature of technology | [4]Chance of success |
|---|---|---|---|---|
| Disability with one leg | Yes | Yes | 3D Printing | 100% |

4**. Brief Description of the Project:**

Prosthetic devices playing major role in bringing the happiness in the lives of people those who are seriously suffering with disabilities and making them more independent and fulfilling lives. However there is a much scope in the improvement of prosthetic devices, and in the coming years, prosthetic devices holds great promise.

In the recent years rapid developments has been taken place in the prosthetics, one of the great significant change is usage of advanced materials and additive manufacturing technology in manufacturing of prosthetic devices. Advanced materials like polymers, metal matrix composite materials enabled the devices more lighter, durable and more comfortable for the user. Additionally, artificial intelligence, sensor technology and deep learning have made possible to create smart prosthetic devices, these devices can respond to the user's body movements, muscle movements and also provide sensory feedback. In addition, important advancements have been implemented in integrating prosthetic devices with the user's nervous system and also important progress has been made in the development of brain devices interfaces that can interpret signals from the user's brain and translate them into the prosthetic movements. This technology very useful to the people with spinal card injuries or other conditions that limit the mobility.

However, despite of these advancements, still there are issues or problems associated with prosthetic devices; one of the most significant issues is affordability. Prosthetic devices, especially the best ones, can be expensive making them inaccessible to much number of disabled persons who would benefit from them. Another important issue about prosthetic devices is longevity. Many of these devices are subject to constant wear and tear and their function often relies on the materials used in their construction. However, despite of using advanced materials like polymers, there are still issues regarding their, long term reliability, discomfort, and skin irritation for the end user. So Continuous research & development in the area of prosthetic device materials science are very much important to address these challenges and ensure that these prosthetic devices very much accessible and effective for all individuals in need

In a prosthetic leg, Socket is the important part that joins the residual limb of the end user with the rest of the prosthetic limb. Young children grow rapidly, which can lead to problems in accommodating the prosthetic socket to the residual limb of the young children due to the size and volume changes. This can increase the rehabilitation cost significantly. Now a day's artificial manufacturing technology most regularly used in the manufacturing of 3D printed socket for affordability, so for a better mechanical performance of prosthetic socket a proper design and analysis is required.

Generally the prosthetic sockets are subjected to the combination of bending and compressive loads. These types of loads are due to the posture and weight of the user. So structural integrity of the prosthetic socket is very essential for examining the safety of the prosthesis. Many investigations have been done for adult users but there is no investigations on the young children prosthetics in the literature.
So this project mainly focuses on selection of material and structural integrity of the 3D printed pediatric prosthetic socket using experimental and numerical analysis.

## 5.Brief details of literature survey and existing patents in the proposed intervention:

Several researchers studied performance of materials and different methods of manufacturing of prosthetic sockets and also studied the mechanical performance of the sockets using finite element methods

Merel van der et al [1] Mechanical properties of the 3D printed prosthetic socket materials are studied with reference to ISO 527 standards and concluded that the FFF- printed sockets are more useful and safe for adult age people, also investigated the structural integrity of the printed socket using the strength on the basis of ISO 10328 standards and suggested that tough PLA is the best material for socket.

Nickel, E.A et al[2] investigated the strength of definitive transtibial prosthetic sockets, which are manufactures with additive manufacturing( 3D printing) technology and tested twenty four 3D printed sockes on the basis of ISO 10328 ultimate tensile strength standards and refined the design of the socket for P6 level load.

M. J. Jweeg, et al. [3] Mechanical properties of the prosthetic socket materials studied by exposing the samples to the tensile and flexural tests and also studied the properties by increasing and decreasing the material layers.
C. Mario et al.,[4] Selective laser sintering technique was used in the manufacturing of prosthetic socket and studied the structural integrity of the socket using finite element method.

R. Abd Al-razaq, et al.,[5] investigated the prosthetic socket mechanical performance using only static loads and used composite material used in prosthetic device manufacturing.

In many of the investigations, very small amount work has been reported on 3D printed prosthetic socket materials, not considered the compressive and bending loads on the sockets and structural integrity, but mainly focused on adult users.

However, in many of the investigations on materials and analysis of mechanical performance of 3D printed pediatric prosthetic sockets has been limited. This project mainly focuses on design and manufacturing of a socket for young children with effective material, also doing investigations on structural integrity, by conducting experiments and finite element analysis.

**References**


1. Van der Stelt, M.; Verhamme, L.; Slump, C.H.; Brouwers, L.; Maal, T.J.J. Strength testing of low-cost 3D-printed transtibial prosthetic socket. *Proc. Inst. Mech. Eng. Part H J. Eng. Med.* **2022**, *236*, 367–375
2. Nickel, E.A.; Barrons, K.J.; Owen, M.K.; Hand, B.D.; Hansen, A.H.; Desjardins, J.D. Strength Testing of Definitive Transtibial Prosthetic Sockets Made Using 3D-Printing Technology. *JPO J. Prosthet. Orthot.* **2020**, *32*, 295–300
3. M.J.Jweeg .S.S.Hasan and J.S.Chiad 2008 Effects of Lamination Layers on the Mechanical Properties for Above Knee Prosthetic Socket Eng. Technol. J. 759-776
4. Faustini M C, Neptune R R, Crawford et al 2006 An Experimental and Theoretical Framework for Manufacturing prosthetic socket Ieee Transactions on Neural Systems and Rehabilitation Engineering vol 14 pp 304-10
5. Al-razaq I R A and Yasir Khalil Ibrahim ,2016, Modular Socket System Versus Vacuum Technique in Trans-tibial Prosthetic Socket Int. J. Energy Environ. 457-468


## 6 Existing state of art in the proposed field/intervention/subject:

In the recent years rapid developments has been taken place in the prosthetics, one of the great significant change is usage of advanced materials and additive manufacturing technology in manufacturing of prosthetic devices. Advanced materials like polymers, metal matrix composite materials enabled the devices more lighter, durable and more comfortable for the user. Additionally, artificial intelligence, sensor technology and deep learning have made possible to create smart prosthetic devices, these devices can respond to the user's body movements, muscle movements and also provide sensory feedback. In addition, important advancements have been implemented in integrating prosthetic devices with the user's nervous system and also important progress has been made in the development of brain devices interfaces that can interpret signals from the user's brain and translate them into the prosthetic movements. This technology very useful to the people with spinal card injuries or other conditions that limit the mobility.

## 7.Importance of the proposed project in the context of current status

despite of these advancements, still there are issues or problems associated with prosthetic devices; one of the most significant issues is affordability. Prosthetic devices, especially the best ones, can be expensive making them inaccessible to much number of disabled persons who would benefit from them. Another important issue about prosthetic devices is longevity. Many of these devices are subject to constant wear and tear

and their function often relies on the materials used in their construction. However, despite of using advanced materials like polymers, there are still issues regarding their, long term reliability, discomfort, and skin irritation for the end user. So Continuous research & development in the area of prosthetic device materials science are very much important to address these challenges and ensure that these prosthetic devices very much accessible and effective for all individuals in need

Generally the prosthetic sockets are subjected to the combination of bending and compressive loads. These types of loads are due to the posture and weight of the user. So structural integrity of the prosthetic socket is very essential for examining the safety of the prosthesis. Many investigations have been done for adult users but there is no investigations on the young children prosthetics in the literature.
So this project mainly focuses on selection of material and structural integrity of the 3D printed pediatric prosthetic socket using experimental and numerical analysis.

**8 objectives**

The main objectives of the projects are

1. Design of the prosthetic socket for young children
2. Experimental and numerical Analysis of structural integrity of the socket
3. Proper Material and design parameter selection for prosthetic socket for young children
4. Fabrication of prosthetic socket for young children

## 9.Novelty of the project:

Young children grow rapidly, which can lead to problems in accommodating the prosthetic socket to the residual limb of the young children due to the size and volume changes. This can increase the rehabilitation cost significantly. Now a day's artificial manufacturing technology most regularly used in the manufacturing of 3D printed socket for affordability, so for a better mechanical performance of prosthetic socket a proper design and analysis is required to maintain the reliability and longevity.

## 10. Methodology

This project implementation mainly covers four phases

1. Design of prosthetic socket for a 15 year old male's residuum using CAD
2. Manufacturing the prosthetic socket using 3D printing technology with different materials
   i. PLA ( polylactic acid)--- Tensile strength 45MPa & Elastic Modulus 2000MPa,
   ii. ABS(Acrylonitrile butadiene styrene)----Tensile strength 38MPa & Elastic Modulus 1310MPa,
   iii. Polycarbonate (PC)--- Tensile strength 36MPa & Elastic Modulus 1000MPa,

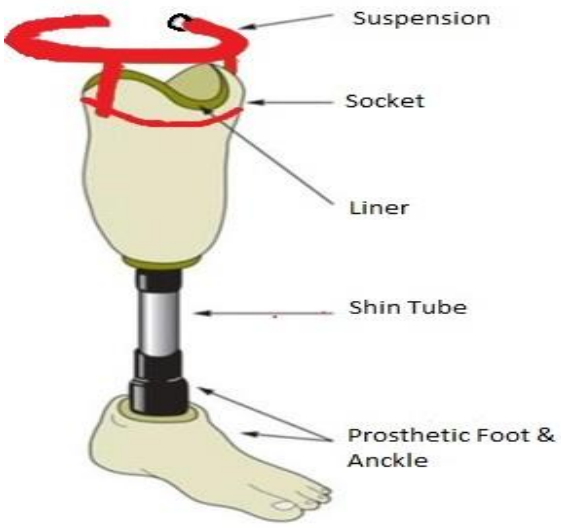
3. Investigation of the structural integrity of the socket by conducting principal strength test at static and cyclic loads using ANSYS software and also by performing mechanical tests experimentally.
4. Analysis of PLA ( polylactic acid), ABS(Acrylonitrile butadiene styrene) and Polycarbonate (PC) 3D printed socket materials performance at static and cyclic loads.

Based on the results Selection of proper Material and design parameter selection for prosthetic socket for young children.

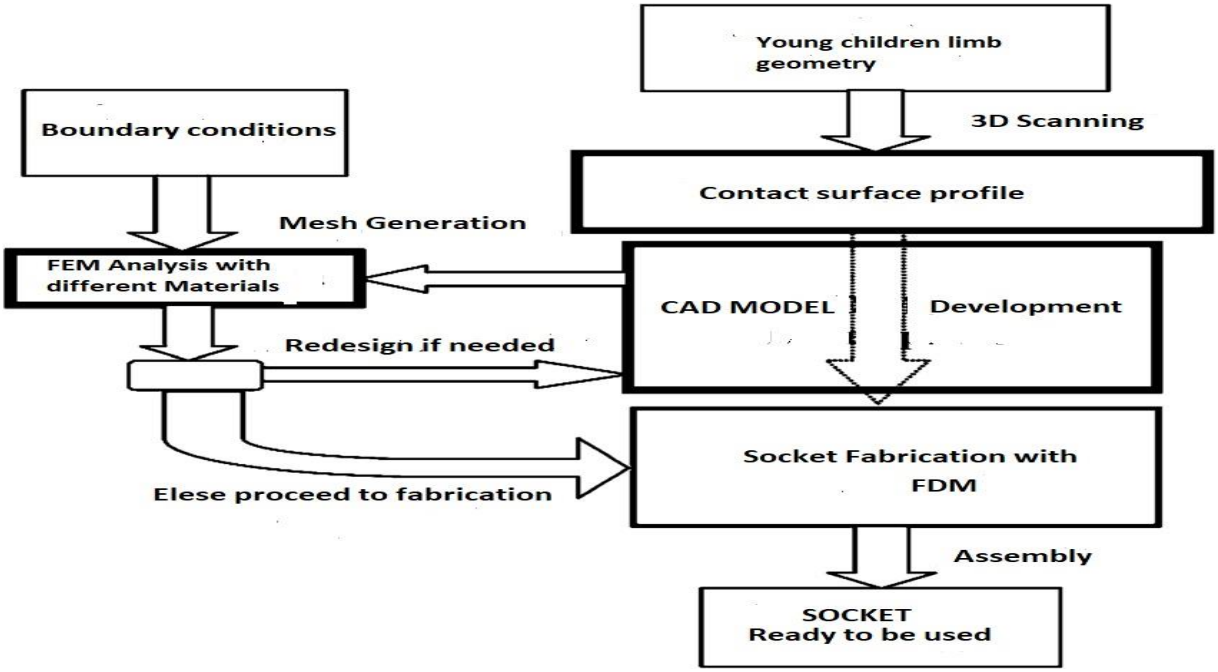
## 11 Work plan

| Activity | Number of months | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| Receive Grant | | | | | | | | | | | | | | | | | | | | | | |
| Purchase& Receipt of equipment | | | | | | | | | | | | | | | | | | | | | | |
| Commissioning, Testing of equipment | | | | | | | | | | | | | | | | | | | | | | |
| Design of prosthetic socket | | | | | | | | | | | | | | | | | | | | | | |
| Manufacturing of prosthetic socket using 3D printer with different materials | | | | | | | | | | | | | | | | | | | | | | |
| Testing the socket at loads | | | | | | | | | | | | | | | | | | | | | | |
| FE Analysis of Socket | | | | | | | | | | | | | | | | | | | | | | |
| Study on structural integrity and materials performance | | | | | | | | | | | | | | | | | | | | | | |
| Results compilation and report submission | | | | | | | | | | | | | | | | | | | | | | |
| Research assistance/ guidance/ consultancy( will continue) | | | | | | | | | | | | | | | | | | | | | | |

12 **Diagrammatic representation of the proposed prototype/ product and flow chart in case of process/protocol**




Modification to existing prosthetic socket(Red colour)




Flow chart on Analysis and fabrication of socket for pediatrics

**13. Expected S&T Deliverables (3-4 significant deliverables each year):**

| *Year* | *Deliverables (which can be monitored or assessed)* |
|---|---|
| First | Young children limb geometry data, Deisgn of socket , Meshing |
| Second | Finite element analysis results, Material selection, Fabrication |

**14. Suggested plan of action for utilization of the outcome expected from the project**

The outcome of the project is very helpful to the prosthetic limb manufacturers, the design data, details about the better material and the structural integrity of 3D printed prosthetic socket for pediatrics data will be shared among the prosthetic limb manufacturers, definitely the outcome of the project will make the disabled paediatrics, to live independently with more comfort.

**15. Short Bio-data of PI & Co-PI (With Educational Qualifications):**

| | |
|---|---|
| i. Principal Investigator | |
| Name | Dr B Sridhar Babu |
| Date of Birth | 08/05/1974 |
| Highest Qualification | PhD |
| Designation | Professor |
| Department | Mechanical Engineering |
| Institute/University | Malla Reddy Engineering college |
| Expertise in the proposed area of work. Whether had done any in projects in the proposed area of work | Yes (on 3D Printing) |
| E-Mail & Mobile Number | bsridhar8477@gmail.com |
| ii. Co-Investigator | |
| Name | Dr.I.S.N.V.R.Prashanth |
| Sex and Date of Birth | Male. 10/12/1977 |
| Highest Qualification | PhD |
| Designation | Associate Professor |
| Department | Mechanical Engineering |
| Institute/University | Malla reddy Engineering college |
| Expertise in the proposed area of | manufacturing |

| | |
|---|---|
| work. Whether had done any in projects in the proposed area of work | |
| E-Mail & Mobile Number | Prasanth5109@gmail.com |

**16. Project Duration : 2 years**

**17. Budget Summary**: Rs. 2700000

Recurring Cost : Rs.20,20,000

Non-Recurring cost : Rs.6,80,000

| *Sl. No.* | *Items* | *Budget (in Rs.)* | | | |
|---|---|---|---|---|---|
| | | *1st Year* | *2nd year* | | *Total* |
| *A.* | *Recurring* | | | | |
| 1. | Manpower | 2, 40,000 | 2,40,000 | | 4,80,000 |
| 2. | Consumables | -- | 1,00,000 | | 1,00,000 |
| 3. | Travel | 30,0000 | 30,000 | | 60000 |
| 4. | *Trainings/Awareness/Field Trials/Dissemination and Deployment etc | --- | --- | | |
| 5. | *Other Costs (including technology testing and validation, patents etc) | 50000 | 50000 | | |
| 5. | Contingency | 10000 | 10000 | | 20000 |
| 6. | Overheads | 10000 | 10000 | | 20000 |
| | *Total (A)* | | | | *6,80,000* |
| B. | *Non-Recurring* | | | | |
| 1. | Equipment | 6,00,000 | 14,00,000 | | 20,00,000 |
| 2. | Fabrication Costs | | 20,000 | | 20,000 |
| | *Total (B)* | | | | *20,20,000* |
| | *Grand Total (A+B)* | | | | *27,00,000* |

**18. Details of Collaborators:**

| *Sl. No.* | *Name of the organisation* | ***Purpose of collaboration* |
|---|---|---|
| 1 | Malla Reddy Hospitals, Hyderabad | For residual limb geometry and dimensions purpose , For meeting disable persons |

## PART II. TECHNICAL DETAILS

1. Title of the Project: **Structural integrity and Material selection for 3D printed prosthetic sockets : Numerical and Experimental Analysis for paediatric applications**

**2.Statement of the Problem and Technology Gaps:**

Many of these devices are subject to constant wear and tear and their function often relies on the materials used in their construction. However, despite of using advanced materials like polymers, there are still issues regarding their, long term reliability, discomfort, and skin irritation for the end user. So Continuous research & development in the area of prosthetic device materials science are very much important to address these challenges and ensure that these prosthetic devices very much accessible and effective for all individuals in need.

In a prosthetic leg, Socket is the important part that joins the residual limb of the end user with the rest of the prosthetic limb. Young children grow rapidly, which can lead to problems in accommodating the prosthetic socket to the residual limb of the young children due to the size and volume changes. This can increase the rehabilitation cost significantly. Now a day's artificial manufacturing technology most regularly used in the manufacturing of 3D printed socket for affordability, so for a better mechanical performance of prosthetic socket a proper design and analysis is required.

Generally the prosthetic sockets are subjected to the combination of bending and compressive loads. These types of loads are due to the posture and weight of the user. So structural integrity of the prosthetic socket is very essential for examining the safety of the prosthesis. Many investigations have been done for adult users but there is no investigations on the young children prosthetics in the literature. So this project mainly focuses on selection of material and structural integrity of the 3D printed pediatric prosthetic socket using experimental and numerical analysis.

**a) State the main problem of the targeted users you seek to address**

Disabled young children with 13 to 15 years of age, Young children grow rapidly, which can lead to problems in accommodating the prosthetic socket to the residual limb of the young children due to the size and volume changes. This can increase the rehabilitation cost significantly

**b) What are existing STI gaps and how did you come to know of this**

Gaps identified through the literature survey

Most of the investigations done for adult users but there is no investigations on the young children prosthetics in the literature. Important issue about prosthetic devices is longevity. Many of these devices are subject to constant wear and tear and their function often relies on the materials used in their construction. However, despite of using advanced materials like polymers, there are still issues regarding their, long term reliability, discomfort, and skin irritation for the end user. So Continuous research & development in the area of prosthetic device materials science are very much important to address these challenges and ensure that these prosthetic devices very much accessible and effective for all individuals in need.

**c) Why is it important to solve the identified gaps**

1. To make the disabled paediatrics lives more comfort and independent.
2. To make prosthetic limb devices more affordable and Longevity.

**3. Review of Literature/Status/Earlier Works and/or Initiatives**

**International:**

Several researchers studied performance of materials and different methods of manufacturing of prosthetic sockets and also studied the mechanical performance of the sockets using finite element methods

Merel van der Stelt et al [1] investigated the mechanical properties of the materials used in the 3D printed prosthetic socket according to the ISO 527 and concluded that the FFF- printed sockets are more useful safe for adult age and also investigated the structural integrity of the FFF- printed socket using the strength on the basis of ISO 10328 standards and suggested that tough PLA is the best material for socket.

Nickel, E.A et al[2] investigated the strength of definitive transtibial prosthetic sockets, which are manufactures with additive manufacturing( 3D printing) technology and tested twenty four 3D printed sockes on the basis of ISO 10328 ultimate strength standards and refined the design of the socket for P6 level load.

M. J. Jweeg, et al. [3] investigated the mechanical properties of materials used in prosthetic socket by exposing the samples to the tensile and flexural tests and also studied the properties by increasing and decreasing the material layers.
C. Mario et al.,[4] Selective laser sintering technique was used in the manufacturing of prosthetic socket and studied the structural integrity of the socket using finite element method.

R. Abd Al-razaq, et al.,[5] investigated the prosthetic socket mechanical performance using only static loads and used composite material used in prosthetic device manufacturing.

In many of the investigations, very small amount work has been reported on 3D printed prosthetic socket materials, not considered the compressive and bending loads on the sockets and structural integrity, but mainly focused on adult users. However, in many of the investigations on materials and analysis of mechanical performance of 3D printed pediatric prosthetic sockets has been limited. This project mainly focuses on design and manufacturing of a socket for young children with effective material, also doing investigations on structural integrity, by conducting experiments and finite element analysis

**4. Suggested STI solutions:**

a) Definitely the outcome of the project will make the disabled paediatrics, to live independently with more comfort.

b) A better material will be suggested for the manufacturing of paediatric Prosthetic socket, which will be more affordable and maintains a good structural integrity in the prosthetic socket.

c) Optimised Paediatric prosthetic socket design data can be created

**(a) Nature of proposed interventions:**

| *Sl. No.* | *Category* | *Please tick* |
|---|---|---|
| 1. | Developing at least a Technology Readiness Level (TRL) – 5 AT product | |
| 2. | Enhancing Technology Readiness Level through Large-Scale Field Trials of products (which are at TRL 5 – Technology validation in relevant environment) | √ |
| 3. | Scaling up of products in collaboration with industry partners | |

**b) Outline your idea or solution you plan to develop**

Prosthetic devices are subject to constant wear and tear and their function often relies on the materials used in their construction. However, despite of using advanced materials like polymers, there are still issues regarding their, long term reliability, discomfort, and skin irritation for the end user. So Continuous research & development in the area of prosthetic device materials science are very much important to address these challenges and ensure that these prosthetic devices very much accessible and effective for all individuals in need. In a prosthetic leg, Socket is the important part that joins the residual limb of the end user with the rest of the prosthetic limb. Young children grow rapidly, which can lead to problems in accommodating the prosthetic socket to the residual limb of the young children due to the size and volume changes. This can increase the rehabilitation cost significantly. Now a day's artificial manufacturing technology most regularly used in the manufacturing of 3D printed socket for affordability, so for a better mechanical performance of prosthetic socket a proper design and analysis is required. Generally the prosthetic sockets are subjected to the combination of bending and compressive loads. These types of loads are due to the posture and weight of the user. So structural integrity of the prosthetic socket is very essential for examining the safety of the prosthesis. Many investigations have been done for adult users but there are no investigations on the young children prosthetics in the literature.

So this project mainly focuses on selection of material and structural integrity of the 3D printed pediatric prosthetic socket using experimental and numerical analysis.

**5. Objectives (should not contain the processes/activities involved in the project)**

The main objectives of the projects are

1. Design of the prosthetic socket for young children
2. Experimental and numerical Analysis of structural integrity of the socket
3. Proper Material and design parameter selection for prosthetic socket for young children
4. Fabrication of prosthetic socket for young children

**6. Methodology and Work Plan.**

a. State the methodology in a sequence of clearly defined steps leading to achievement of the project objectives

This project implementation mainly covers four phases

1. Design of prosthetic socket for a 15 year old male's residuum using CAD
2. Manufacturing the prosthetic socket using 3D printing technology with different materials
   i. PLA ( polylactic acid)--- Tensile strength 45MPa & Elastic Modulus 2000MPa,
   ii. ABS(Acrylonitrile butadiene styrene)----Tensile strength 38MPa & Elastic Modulus 1310MPa,
   iii. Polycarbonate (PC)--- Tensile strength 36MPa & Elastic Modulus 1000MPa,

3. Investigation of the structural integrity of the socket by conducting principal strength test at static and cyclic loads using ANSYS software and also by performing mechanical tests experimentally.
4. Analysis of PLA ( polylactic acid), ABS(Acrylonitrile butadiene styrene) and Polycarbonate (PC) 3D printed socket materials performance at static and cyclic loads.

Based on the results Selection of proper Material and design parameter selection for prosthetic socket for young children.

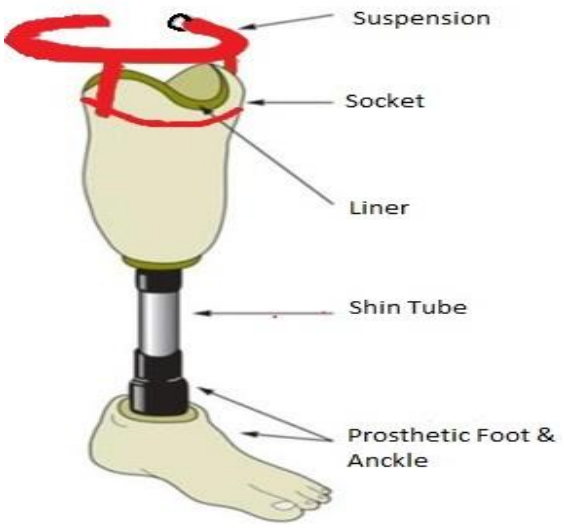
**b. Phase wise plan of action with time lines and deliverables in tabular form or pert diagram**

| Activity | Number of months | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| Receive Grant | | | | | | | | | | | | | | | | | | | | | | |
| Purchase& Receipt of equipment | | | | | | | | | | | | | | | | | | | | | | |
| Commissioning, Testing of equipment | | | | | | | | | | | | | | | | | | | | | | |
| Design of prosthetic socket | | | | | | | | | | | | | | | | | | | | | | |
| Manufacturing of prosthetic socket using 3D printer with different materials | | | | | | | | | | | | | | | | | | | | | | |
| Testing the socket at loads | | | | | | | | | | | | | | | | | | | | | | |
| FE Analysis of Socket | | | | | | | | | | | | | | | | | | | | | | |
| Study on structural integrity and materials performance | | | | | | | | | | | | | | | | | | | | | | |
| Results compilation and report submission | | | | | | | | | | | | | | | | | | | | | | |
| Research assistance/ guidance/ consultancy( will continue) | | | | | | | | | | | | | | | | | | | | | | |

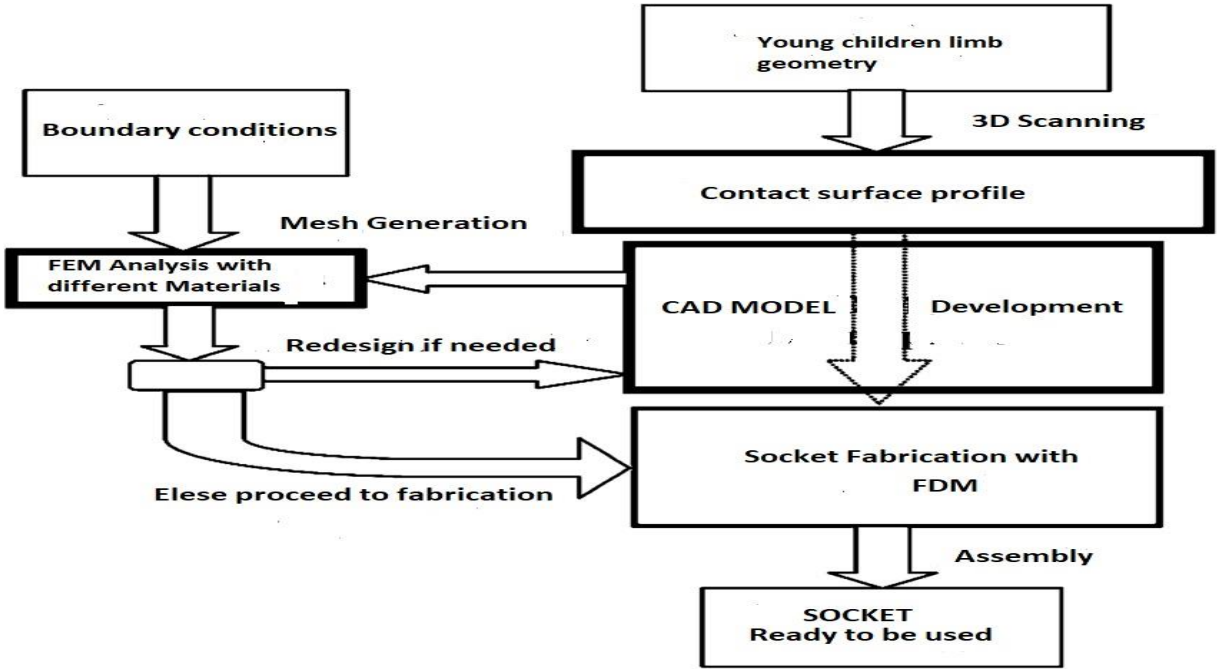
c**. Details/Mechanism for the involvement of target user groups in the project**

Disabled people from the Malla reddy hospital

## 7 Artistic Impression and/or Diagrammatic Representation of the prototype/product




Modification to existing prosthetic socket(Red colour)



Flow chart on Analysis and fabrication of socket for pediatrics

8. **Indicative techno-economic viability/cost benefits analysis of the prototype/product developed**.

3D printed prosthetic devies are more affordable and very cheap compared ti the other devices.

9. **Comment on the likely impact of the project on target groups as well as on the existing state of art in the proposed area of work.**

The outcome of the project is very helpful to the prosthetic limb manufacturers, the design data, details about the better material and the structural integrity of 3D printed prosthetic socket for pediatrics data will be shared among the prosthetic limb manufacturers, definitely the outcome of the project will make the disabled paediatrics, to live independently with more comfort. The additive manufacturing is very easy and more affordable products can be achieved

10. **Whether the project requires in vivo/in vitro studies and requires ethical clearance?**

No

11. Whether the proposed prototype/product proposed developed should adhere to any standards?

YES, ISO standards

12**. Details of Field Trials, Testing and Validation of Proposed Intervention in real time**

Field trials, Testing and validation of proposed device will be conducted at Malla reddy hospital Hyderabad.

**13. Outline your idea for scaling and commercialisation**

The project results will be given to prosthetic device manufacturers without any commercial aspect. the project outcomes are beneficial to disable persons

**14. Suggested parameters (5-6) for monitoring the progress of the project**

| Sl. No | Year | Suggested Parameters/Output/Outcomes |
|---|---|---|
| 1 | 2024 | Young children limb geometry data, Deisgn of socket , Meshing |
| 2 | 2025 | Finite element analysis results, Material selection, Fabrication |

15. Expertise available with the proposed investigating group/institution in the proposed area of work.

**YES,**

## PART III: BUDGET

### A. RECURRING

1. BUDGET FOR MANPOWER

| *Sl. No.* | *Designation* | *Budget (Rs)* | | | |
|---|---|---|---|---|---|
| | | *1st Year* | *2nd Year* | *3rd Year* | *Total* |
| 1. | Research Associate | 2,40,000 | 2,40,000 | | 4,80,000 |
| 2. | | | | | |
| *TOTAL* | | | | | *4, 80,000* |

*(Staff recruited for a project should be paid as per the norms and guidelines of the DST. The justification should contain the work allocation/functions of each project staff. Please refer to different OMs regarding salary structure of various categories of project staff available on DST Website)*

2. BUDGET FOR CONSUMABLES

| *Sl. No* | *Consumables* | *Budget (Rs)* | | | |
|---|---|---|---|---|---|
| | | *1st Year* | *2nd Year* | *3rd Year* | *Total* |
| 1. | polylactic acid | | 30000 | | 30000 |
| 2 | Acrylonitrile butadiene styrene | | 30000 | | 30000 |
| 3 | Poly corbonate | | 40000 | | 40000 |
| *TOTAL* | | | | | *1,00,000* |

3. BUDGET FOR TRAVEL

| *Sl. No* | *Purpose* | *Budget* | | | |
|---|---|---|---|---|---|
| | | *1st Year* | *2nd Year* | *3rd Year* | *Total* |
| 1. | Project Implementation | 20,000 | 20,000 | | 40000 |
| 2. | For attending DST Review Meetings | 10,000 | 10,000 | | 20000 |
| *TOTAL* | | | | | *60000* |

4. BUDGET FOR TRAININGS/AWARENESS/FIELD TRIALS/DISSEMINATION AND DEPLOYMENT ETC

| *Sl. No* | *Description of Trainings User/Field Trials etc* | *Budget* | | | |
|---|---|---|---|---|---|
| | | *1st Year* | *2nd Year* | *3rd Year* | *Total* |
| 1. | | | | | |
| *TOTAL* | | | | | |

5. BUDGET FOR OTHER COSTS

| *Sl. No* | *Description of Other Costs* | *Budget* | | | |
|---|---|---|---|---|---|
| | | *1st Year* | *2nd Year* | *3rd Year* | *Total* |
| 1. | Testing of the Product, validation, patents etc | | | | |

| | | | | |
|---|---|---|---|---|
| *TOTAL* | | | | |

6. BUDGET FOR CONTINGENCIES

| *Sl. No* | *Item* | *Budget* | | | |
|---|---|---|---|---|---|
| | | *1st Year* | *2nd Year* | *3rd Year* | *Total* |
| 1. | Unforeseen Expenditure | 10000 | 10000 | | 20000 |
| TOTAL | | | | | *20000* |

7. BUDGET FOR OVER HEADS

| *Sl. No* | *Item* | *Budget* | | | |
|---|---|---|---|---|---|
| | | *1st Year* | *2nd Year* | *3rd Year* | *Total* |
| 1. | Institutional Overheads | 10000 | 10000 | | 20000 |
| TOTAL | | | | | *20000* |

**B. NON-RECURRING**

| *Sl. No.* | *Item* | *Budget* | | | |
|---|---|---|---|---|---|
| | | *1st Year* | *2nd Year* | *3rd Year* | *Total* |
| 1. | Pro E software | 2,50,000 | | | 2,50,000 |
| 2 | Ansys software | 3,50,000 | | | 3,50,000 |
| 3 | 3D printer | | 4,50,000 | | 4,50,000 |
| 4 | Mechanical strength tester | | 9,50,000 | | 9,50,000 |
| 2. | Fabrication | | 20000 | | 20000 |
| **TOTAL** | | | | | **2020000** |

Detailed justification for each and every item of equipment should be given

Bill of materials/estimate for fabrication and construction cost should be provided

## PART IV: DETAILS OF THE IMPLEMENTING (HOST) INSTITUTE

(In case of Voluntary Organizations/NGOs and Private Institutes please enclose copies of Registration Certificate/Trust Deed, Memorandum of Association including By-laws and

Mandate, Audited statement of accounts for the last three years, Annual Report including activity profile for last three years) – All these documents should be enclosed with the application format and should be uploaded in e-PMS.

1. Details of the Host Institution

| | | |
|---|---|---|
| Name of the Organization | Malla Reddy Engineering College | |
| Address | MALLA REDDY ENGINEERING COLLEGE (Autonomous)<br>MAIN CAMPUS<br>Maisammaguda(H), Gundlapochampally Village,<br>Medchal Mandal,<br>Medchal-Malkajgiri District,<br>Telangana State - 500100 | |
| Telephone with STD code | Phone: 9348161125 | Fax: NA |
| E – mail | principal@mrec.ac.in | |
| Website | https://mrec.ac.in/ | |
| Year of Establishment | 2002 | |
| Registration No & Date | No:5613/2001<br>Date: 21.08.2001 | |
| FCRA Registration No & Date (if applicable) | Section 8<br>U88900TS2023NPL174548 | |
| Annual Budget in last Financial Year | | |
| Operational Area (State & Districts) | State | |
| NGO Darpan Id | TS/2017/0154621 | |
| Unique Code under PFMS | TLML00000156 | |
| Whether Implementing EAT Module in PFMS | YES | |

2. Infrastructure available land/building (including equipment) for executing the project.

**Space Details (**Incubation Space (Cubicles), Maker space, Conference Room, Meeting Rooms, and Other Facilities)**: 21,040 sq.ft**

## List of Major Equipment

| Civil Engineering | | | | |
|---|---|---|---|---|
| **S. No** | **Equipment** | **Particulars** | **Year of purchase** | **Cost (Rs)** |
| 1. | Tri Axial Test | Top Loading Pad, Perspex, 38mm dia, Plain Perspex Disc 38 mm dia x 6 mm thick , Porous Stone 38mm dia x 6 mm thick , Sheath Stretcher for 38mm dia specimen | 2014 | 1,87,500 |
| 2. | Digital Compression Testing Machine 2000Kn | Quality Engineering and Instruments | 06-01-2016 | 3,15,939 |
| 3. | pan mixer constant drum rotating blade type electrically operated fitted with 5Hp 3phase ISI motor cap of 100kg | Quality Engineering and Instruments | 23-11-2010 | 140000 |
| 4. | Hydraulic jump apparatus | Closed Circuit unit | 2016 | 1,64,000 |
| 5. | Pelton wheel turbine | Closed Circut unit | 2003 | 1,59,900 |
| 6. | Francis turbine | Closed Circuit unit | 2003 | 1,80,600 |

| Electrical and Electronics Engineering | | | | |
|---|---|---|---|---|
| **S. No** | **Equipment** | **Particulars** | **Year of purchase** | **Cost (Rs)** |
| 1 | Rectifier | 220V, 100A | 06.11.2003 | 1,10,000 |

| Electronics and Communication Engineering | | | | |
|---|---|---|---|---|
| **S. No** | **Equipment** | **Particulars** | **Year of purchase** | **Cost (Rs)** |
| 1 | Spectrum Analyzer | 0.15MHz to 1050MHz | 23.02.2017 | 1,22,000 |

| Computer Science and Engineering |
|---|

| S.No | Equipment | Particulars | Year of purchase | Cost (Rs) |
|---|---|---|---|---|
| 1 | 1 server | Intel core i7-9900k,16 GB RAM,8 TB Hard Disk,DELL Monitor,Mouse,Keyboard | | |
| 2 | 19 clients | i5-10400,8 GB RAM,1 TB Hard Disk,DELL Monitor,Mouse,Keyboard | 2021 | 5,51,000/- |

| Information Technology | | | | |
|---|---|---|---|---|
| **S.No** | **Equipment** | **Particulars** | **Year of purchase** | **Cost (Rs)** |
| 1 | DESKTOP | Intel Core i3, 1 TB HDD,4GB RAM, 64-bit Processor | | |
| **Mining Engineering** | | | | |
| **S.No** | **Equipment** | **Particulars** | **Year of purchase** | **Cost (Rs)** |
| 1 | Anchorage test apparatus | Pull out of 50tonnes capacity | 2016 | 169400 |
| 2 | Tri axial strength testing apparatus | Rock Tri axial cell for testing rock samples of BX, NX cat no. Aim 211. constant pressure system for rocks pressure 160kg/cmsq, load frame motorised 3 speeds , proving ring | 2019 | 256054 |
| 3 | Uni axial strength testing apparatus | Uni axial compressive strength test machine with main frame with 100KN ring with 2 dial guages | 2019 | 167785 |
| 4 | Wifely shaking table | arrangement for seperating minerals of various densities | 2016 | 265228 |
| 5 | Froath flotation cell | for seperating the concentrate from crushed ore of 15microns size | 2016 | 176818 |

| | | | | |
|---|---|---|---|---|
| 6 | Magnetic separator | Magnetic seperating of minerals arrangement | 2016 | 160616 |
| 7 | Roller crusher | Doublle smooth roller crusher 300mm dia x 200mm W | 2016 | 280665 |
| 8 | Grindability index apparatus | bond index mill 300mn ID X 300MM IL | 2016 | 198000 |
| 9 | Axial flow fan setup | Two axial flow fans with duct pipe | 2015 | 513000 |
| 10 | Direct Shear test apparatus | shear box 300mmx300mm x100mm, jack of 100KN, hydraulic hand pump, load guage 100kn, dial gauges 0.01x25mm | 2019 | 151040 |
| 11 | Mineral jig | arrangement for separating coal and iron ore waste | 2016 | 136080 |
| 12 | Centrifugal fan | fans with duct pipe | 2015 | 183000 |
| 13 | Electronic total station - 325 | Horizon made Electronic total station 325 model | 2006 | 278623 |
| 14 | Electronic total station - 555 | Horizon made Electronic total station 555 model | 2008 | 221825 |

**Dr. B.SRIDHAR BABU Ph.D., M.Tech, B.Tech**

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Ragavendra Nagar, Nacharam, Hyderabad-500 076(TS).
**Contact:** 9247969234.
**E-Mail:** bsridhar8477@gmail.com
**ORCID:** 0000-0002-3721-813Xz

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## RESEARCH INTERESTS

- Solid Mechanics/Contact Mechanics, Stress Analysis
- Characterization of Materials
- Manufacturing

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## EDUCATIONAL QUALIFICATIONS

| Year | Education |
|---|---|
| **2016** | **Ph.D., JNTUH, Hyderabad** (Mechanical Engineering)<br>**Thesis:** Indentation size effects on elasto-plastic deformation behavior of materials for aero engine components. (**Mechanics of solids)** |
| **2010** | **M.Tech., ANU, Guntur,** (Computer Science and Engineering) |
| **2005** | **M.Tech., JNTUH, and Hyderabad** (Advanced Manufacturing systems), |
| **1999** | **B.Tech., KITS Warangal.** (Mechanical Engineering), |
| **1995** | **Diploma, Govt. Polytechnic, Warangal,** (Mechanical Engineering), |

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## PROFESSIONAL EXPERIENCE: 20 years

Malla reddy Engineering college — Spet 2023 t0 till date
**Professor**
Sri Venkateswara College of Engineering and Technology — Dec 2021 to Aug 202
**Professor**
CMR Institute of Technology, Hyderabad. — July, 2009 to Nov 2021
**Professor & Dean of IIIC**
RRS College Of Engineering, Hyderabad — Aug, 2003 to June 2003
**Associate Professor & HOD**
Bharath Institute of Technology & Science, Hyderabad — June 2001 to May 2003
**Assistant Professor**
Mother Therisa Institute Of Science and Technology — Sep, 1999 to April 2001
**Assistant Professor**

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## TECHNICAL PUBLICATIONS:

- International Journals (SCI/Scopus/WoS): **25**
- International Journals (Peer Reviewed/UGC Indexed): **18**
- National / International Conferences: **07**
- Books/Book Chapters: **13**

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## INSTITUTIONAL MEMBERSHIPS:

- Fellow member of institute of engineers
- Life Member of Indian Society for Technical Education
- Member of SAE India
- Member of international association of engineers

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## GUEST EDITOR:

- **Academic Editor** for **Journal of Engineering** Hindawi Publications
- **Academic Editor** for **Advances in Polymer Technology** Hindawi Publications
- **Academic Editor** for **Advancesin Materials Science and Engineering**, Hindawi Publications
- "**Processing, Characterization and Application of Light weight materials**" Special issue of Advances in Materials Science and Engineering, Hindawi Publishers( SCI & Scopus indexed journal.
- ***'Advances in Materials Processing and Techniques***' a Topical Collection of SN Applied Sciences, **Springer Nature journal** (ESCI Indexed)
- Proceedings of 3rd International Conference on Manufacturing, Material Science and Engineering (ICMMSE'20), **AIP Proceedings** (Scopus and WOS indexed).

- Proceedings of 2nd International Conference on Manufacturing, Material Science and Engineering (ICMMSE'20), **Materials Today - Proceedings** (Scopus and CPCI Indexed).
- Proceedings of 2nd International Conference on Manufacturing, Material Science and Engineering (ICMMSE'20), **AIP Proceedings** (Scopus and CPCI Indexed, WOS).
- Proceedings of International Conference on Research and Advances in Mechanical Engineering (ICRAME 2020), **IOP Conference Series: Materials Science and Engineering** (Scopus and CPCI Indexed).
- Proceedings of 1st International Conference on Manufacturing, Material Science and Engineering (ICMMSE'19), **MaterialsToday- Proceedings**(Scopus and CPCI Indexed).
- Proceedings of 1st International Conference on Manufacturing, Material Science and Engineering (ICMMSE'19), **AIP Proceedings** (Scopus and CPCI Indexed, WOS).

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**LIST OF PUBLICATIONS:**

**International Journals (SCI/ESCI/SCIE/ SCOPUS / WoS):**

1. B Sridhar Babu, A Kumaraswamy and **Kaushik Kumar,** *Effect of Macro, Micro and Nano Loads on The Indentation Behaviour of Ti-6Al-4V And Haynes 242 Alloys,* **International Journal of Automotive and MechanicalEngineering(IJAME)**; 19(2),9816-9822, 2022, https://doi.org/10.15282/ijame.19.2.2022.15.0757; ISSN: 2180–1606 **(IF 0.331)**
2. Harinadh V, Edison G, Kaushik Kumar, Paolo Ferro, **B Sridhar Babu**, *Thermal and Residual Stress Distributions in Inconel 625 Butt-Welded Plates: Simulation and Experimental Validation* ***Advances in materials science and Engineering, (Hindawi) SCI, (IF.1.75)*** http://doi.org/10.1155/2021/3948129.
3. Harinadh Vemanaboina, Edison Gundabattini, B Sridhar Babu, Paolo Ferro and **Kaushik Kumar**, *Effect of Heat Input on Distortions and Residual Stresses Induced by Gas Tungsten Arc Welding in SS 316L To INCONEL625 Multipass Dissimilar Welded Joints,* **Advances in Materials Science and Engineering** (Special Issue: Processing, Characterization, and Applications of Lightweight Materials)

2021 (Article ID 1028461); https://doi.org/10.1155/2021/1028461, ISSN: 1687-8442 (**IF 2.098**)

4. Balram Y, **B Sridhar Babu**, Venkata Ramana G, *Comparison of metallurgical and mechanical properties of dissimilar joint of AISI 316 and Monel 400 developed by pulsed and constant current gas tungsten arc welding processes*. **The international Journal of Advanced Manufacturing Technology, Springer, (SCI) (IF:2.99)**2020 (http://doi: 10.1007/s00170-020-05562-w).
5. S. Sathees Kumar, **B. Sridhar Babu**, K Tirupathi, *Comparison of Ductile, flexural, Impact and hardness attributes of sisal reinforced polyester composites*, **Intelligent Manufacturing and Energy Sustainability (Springer)** 2020 (http://doi: 10.1007/978-981-15-1616-0_62)**.**
6. S.SatheeshKumar,T.VishnuVardhan,**B.SridharBabu**.*Dataset on tribological characterization and thermal properties of silicon carbide reinforced polyamide composites for industrial applications*,**DatainBrief,Elsevier(ESCI&SCOPUS)(IF:1.5)**2020,(http://doi:10.1016/j.dib.2020.105662).
7. **B. Sridhar Babu** and Kaushik Kumar**,** *Temperature Dependence of Indentation Behavior of Ti-6Al-4V Alloy for Bio Medical Applications* **Bio interface Research in Applied Chemistry**, ISSN: 2069-5837, **(SCOPUS &WoS) (IF: 1.5)** 2020 (http://doi: 10.33263/BRIAC96.629234)
8. S. Marichamy, M. Ravichandran, B. Stalin, B**. Sridhar Babu** '*Optimization of Abrasive Water Jet Machining Parameters for α-β brass using Taguchi Methodology*' **FME Transactions (SCIE & SCOPUS) ( IF : 1)** (2019). (http://doi.10.5937/fmet1901116M)**.**
9. T. Vishnu Vardhan , S. Marichamy and **B. Sridhar Babu**, *Effects of Graphite Particles in Titanium Metal Matrix Developed by Spark Plasma Sintering Process'* **Lecture Notes in Mechanical Engineering (Springer) (SCOPUS)** 2019**,(**http://10.1007/978-981-32-9931-3-26)
10. **B Sridhar Babu,** A Kumaraswamy, B Anjaneya Prasad '*Elasto-plastic Deformation Behavior of Ti- 6Al-4V and Haynes242 Alloys at Nanoscale Loads*' **International Journal of Materials Science**, (**SCOPUS)** 2014 (http://doi:10.1007/S12666-015-0550-8)
11. **B Sridhar Babu**, A Kumaraswamy, B Anjaneya Prasad '*Effect of Indentation Size and Strain Rate on Nanomechanical Behavior of Ti-6Al-4V Alloy*' **Transactions of Indian institute of metals Springer**, **(SCIE & SCOPUS) (IF:1.4)** 2014, (http://10.1007/S12666-014-0438-Z)
12. **B Sridhar Babu**, A Kumaraswamy, B Anjaneya Prasad, *Investigation of Elasto-Plastic Deformation Behavior of Haynes242 Alloy Subjected to Nanoscale Loads through Indentation Experiments*' ***Transactions of Indian institute of metals Springer***, **(SCIE & SCOPUS) (IF:1.4)** 2015,( http://10.1007/S12666-015-0550-8)
13. **Sridhar Babu B,** Kumaraswamy A, Anjaneya Prasad B. '*Numerical analysis of effect of friction on mechanical properties of Ti-6Al-4VAlloy through Nanoindentation*' ***Procedia Engineering (Elsevier)*** (2013) (http://10.1016/j.proeng.2013.09.182).
14. **B. Sridhar Babu** and M Srinivas**,** *A Critical Review on Recent Research Methodologies in additive Manufacturing*, **Materials today (Elsevier)** (**SCOPUS)** 2017 (https:// doi.org/ 10.1016/ j.matpr.2017.07.258).
15. **Sridhar Babu B,** Kumaraswamy, *A Novel method of evaluating flow curve for SS304 form low cost indentation experiments,* **ARPN journal of engineering and Applied sciences,(SCOPUS) 2011.**
16. **Sridhar Babu B,** Senthil kumar, *Comparative Modeling on Surface Roughness for Roller Burnishing process using Fuzzy Logic,* ***International Journal of Mechanical and Production Engineering Research and Development*** **(SCOPUS)** 2018 (http://doi.org/10.24247/ijmperdfeb 2018)
17. A Naga Sai Ranganayakulu, D Devsingh**, B Sridhar Babu,** Vishnu Vardhan,T *Experimental development of pultrusion moulds*, ***Materials Today*** (***Elsevier***) 2019 (***SCOPUS***) (https://doi.org/10.1016/j.matpr.2019.07.612)
18. Balram Y, **B Sridhar Babu**, Venkat Ramana G *Thermal Stress Analysis Of AISI 316 Stainless Steels Weldments In TIG And Pulse TIG Welding Processes*. ***Materials Today*** (***Elseveir***) (***SCOPUS***) 2019 (https://doi.org/10.1016/j.matpr.2019.06.695).
19. Balram Y,Sriramoju Avinash, **B Sridhar Babu**, Venkat Ramana Gunda, *Multi-response optimization of pulse TIG welding process parameters of welds AISI 304 and Monel 400 using grey relational analysis,* ***Materials Today*** ( ***Elseveir***) (***SCOPUS***) (https://doi.org/10.1016/j.matpr.2019.07.211)

20. Balram Y,Sravan Kumar, **B Sridhar Babu**, Venkat Ramana G, *Effect of filler wires on weld strength of dissimilar pulse GTA monel 400 and AISI 304 weldments.* ***Materials Today (Elsevier) (SCOPUS),*** *(*https://doi.org/10.1016/j.matpr.2019.06.759).
21. Balram Y, **B Sridhar Babu**, Venkat RamanaG, *Residual stress analysis of dissimilar tungsten inert gas weldments of AISI 304 and Monel 400 by numerical simulation and experimentation,* ***Materials Today (Elseveir) (SCOPUS),*** *(*https://doi.org/10.1016/j.matpr.2019.07.639)
22. **B Sridhar babu**, V Srikanth, Balram Y,*Numerical analysis on indentation behavior of Ti- 6Al-4V),****MaterialsToday****(****Elseveir****)(****SCOPUS****),*201,(https://doi.org/10.1016/j.matpr. 2019.08.139).
23. M. A. Ali Baig, Azeem,**B. Sridhar Babu,***Porous Cylinder Subjected To Conjugate Heat Transfer-PartII*. ***AIP Conference Proceedings, (SCOPUS),***(https://doi.org/10.1063/1.5141242).
24. M. A. Ali Baig, Azeem,**B. Sridhar Babu,** *Porous Cylinder Subjected To Conjugate Heat Transfer-PartII*. ***AIP Conference Proceedings, (SCOPUS),*** *(*https://doi.org/10.1063/1.5141240).
25. Chikesh Ranjan S, Nikhil, **B Sridhar Babu,** *Design and Demonstration of Manual Operated Pedalo Water Boat for Garbage Collection from Lake,* ***AIP Conference Proceedings, (SCOPUS)*** *(*https://doi.org/10.1063/1.5141267).
***26.*** Chikesh Ranjan S, **B Sridhar Babu,** Design and Fabrication of Quad copter with Rechargeable Solar Power Source ***AIP Conference Proceedings, (SCOPUS),*** (https://doi.org/10.1063/1.5141174***).***

**International Journal Papers (Peer Reviewed):**

1. Vijay Kumar T, **B.Sridhar Babu**, Rakesh Jalla. 'Experimental and theoretical study on effect of welding speed and tool pin profiles on aluminum friction stir welded butt joints.' ***International Journal of Research in Engineering & Advanced Technology,*** Volume 1, Issue 4, Aug-Sept, 2013
2. Y Balram, **B Sridhar Babu**, Harinadh Vemanaboina, K Chandrasekhar 'Prediction of Residual Stresses and Distortion in GTAW Process- A Review' ***International Journal of Advance Research and Innovative Ideas in Education*** ISSN (O)-2395-4396, Volume 2, Issue 2, April 2017.
3. **Sridhar Babu B**, Kumaraswamy A, Anjaneya Prasad B, Relevance of Nano indentation Experiments in Materials Research-A Review.' ***Advanced Materials Manufacturing & Characterization*** Volume 3 Issue 1 (2013).
4. P.Shravan Kumar, **B.Sridhar Babu**. 'Development and Analysis of Connecting Rod from the 3D scanned data by Reverse Engineering Technique using Catia.' ***International Journal of Research in Engineering & Advanced Technology,***Volume 2, Issue 1, Feb-Mar, 2014
5. Priyadarsini M, **Sridhar Babu .B**, Rakesh Jalla. 'Non-Destructive Evaluation of Elasto Plastic Properties of Inconel alloy through Microindentation.' ***International Journal of Research in Engineering & Advanced Technology,*** Volume 1, Issue 4, Aug-Sept, 2013
6. Swathy B, **B.Sridhar Babu**. 'Dynamic Analysis of a Hermetic Reciprocating Compressor.' ***International Journal of Latest Trends in Engineering, Science and Technology,*** Volume 1 Issue5 May 2014.
7. **B.Sridhar Babu**, Pawar Deepak Dinkarrao. 'Computational Fluid Dynamics and Experimental Analysis for Optimum Geometry of Vortex Tube.' ***International Journal of InnovativeResearch in Science, Engineering and Technology,*** Volume 3, Issue 8, 2014
8. Raghunandan K, **B. Sridhar Babu**. 'Electro-Mechanical System Design for Seating Systems.**'** ***International Journal of Engineering Research and Technology,*** Volume 3, Issue 7,July- 2014
9. Valmeti Sudheer, **B Sridhar Babu** 'Computational Fluid Dynamics Analysis of a Building ventilation solar chimney' *International Journal of Advance Research and Innovative Ideas in Education* ISSN (O)-2395-4396, Volume 2, Issue 2, April 2017.
10. L. Durga Prasad, D Dev Singh, **B Sridhar Babu** 'Static and Dynamic Analysis of Centrifugal Blower using composite material' ***International Journal of Latest Trends in Engineering Science and Technology,*** Volume 2, Issue 3,Oct. 2015.
11. Srinivas Namana, D Dev Singh, **B Sridhar Babu** 'Prediction of Behavior of Composite Material Low pressure Vessels under Various Loadings' ***International Journal of Latest Trends in Engineering Science and Technology,*** Volume 2, Issue 3,Oct. 2015.

12. G Venkatesh, G Venkata Ramna, **B Sridhar Babu** 'Simulation of Friction stir welding process parameters of Al 5086-HE15, Al 6061-HE20 joints' ***International Journal of Latest Trends in Engineering Science and Technology,*** Volume 2, Issue 3,Oct. 2015
13. N Srujana, **B Sridhar Babu** 'Comparative Study of performance of Acoustic Horns of different profiles using FEA' ***International Journal of Latest Trends in Engineering Science and Technology,*** Volume 2, Issue 3,Oct. 2015
14. Siva RamaKrishna, G Venkata Ramna, **B Sridhar Babu** 'Design of the Impulse Tubing Assembly Structure for Seismic Conditions' ***International Journal of Latest Trends in Engineering Science and Technology,*** Volume 2, Issue 3,Oct. 2015.
15. **B Sridhar Babu** Development and Analysis of Connecting Rod from the 3D scanned data by Reverse Engineering Technique using Catia International ***Journal of Research in Engineering & Advanced Technology*** 2320-8791.
16. **B Sridhar Babu** An experimental study on the effect of diameter and rotational speed on mechanical behavior ofAA6063-T6 friction welded joints International ***Journal for Scientific Research & Development- IJSRD*** 2321-0613
17. M Srinivas and **B Sridhar Babu** Development of High Strength,High Toughness and High Wear Resistant Parts for Mud Pump ***International Journal of Innovations in Engineering and Technology (IJIET)*** 2319-1058
18. Valmeti Sudheer, **B Sridhar Babu** Thermal analysis of Automobile Oil Sump ***International Journal of Advance Research and Innovative Ideas in Education*** ISSN (O)-2395-4396, Volume 2, Issue 2, April 2017.

### National & International Conference Papers

1. A Kumaraswamy, **B Sridhar Babu**, B Anjaneya Prasad 'Non-destructive evaluation of elasto- plastic properties of Ti-6Al-4V alloy through Nanoindentation' NDE 2012, December 10 to 13, 2012/Cp-51, p27 **DOI :**10.1016/j.matdes.2011.01.003
2. **B Sridhar Babu**, A Kumaraswamy, B Anjaneya Prasad, A Computational study of factors affecting the characterization of Nanoindentation in Ti-6Al-4V alloy" The Fifty seventh Congress of the Indian society of theoretical and applied mechanics (An international meet) Pages 115 to120, DIAT, PUNE.
3. **B Sridhar Babu**, A Kumaraswamy, B Anjaneya Prasad, Effect of strain rate on mechanical properties of Ti-6Al- 4V alloy through Nanoindentation National conference on Micro &Nano Fabrication- CMTI Bangalore, January 21st to 23rd 2013 Pages 127 to 131,
4. **B Sridhar Babu**, A Kumaraswamy, B Anjaneya Prasad, Effect of strain rate on mechanical behavior of Haynes 242 alloy through Nanoindentation, National conference on Emerging trends in mechanical engineering,- Osmania University, Hyderabad
5. Y Balram, **B Sridhar Babu**, An experimental study on the effect of diameter and rotational speed on mechanical behavior of AA6063-T6 friction welded joints National conference on recent trends& innovations in mechanical engineering- NNREC-Hyderabad
6. **B Sridhar Babu**, A Kumaraswamy, B Anjaneya Prasad, Investigation on indentation behavior of Ti-6Al-4V alloy 7th International & 28th All India Manufacturing Technology, Design and Research (AIMTDR) Conference 2018 December 13th-15th 2018, College of Engineering Guindy, Anna University, Chennai, India.
7. S Sateesh Kumar**, B Sridhar Babu**, Comparision of ductile, flexural, impact and hardness attributes of sisal fiber reinforced polyester composites, International conference on intelligent manufacturing and energy sustainability, Malla reddy college of engineering and technology, Hyderbad, June 21-22, 2019.

## Books Published:

1. **Kumar, K.** and Sridhar Babu, B., *Hybrid Composites: Processing, Characterization and Applications*, (ISBN 978–3–11–072468–4) **Verlag Walter de Gruyter GmbH, GERMANY (**https://www.degruyter.com/document/isbn/9783110724684/html)

2. **Kumar, K.** and Sridhar Babu, B., *Advances in Industrial Automation and Robotics*, (ISBN 978–0–36–748797–3) **CRC Press (A Taylor & Francis Company), USA. (**https://www.routledge.com/Industrial-Automation-and-Robotics-Techniques-and-Applications/Kumar-Babu/p/book/9780367487973)
3. **Kumar, K.**, Sridhar Babu, B. and Davim, J. P., *Light Weight Materials: Processing and Characterization*, (ISBN: 978–1–78–630797–2) **ISTE Science Publishing Ltd. UK.** (http://iste.co.uk/book.php?id=1810) **2021**
4. **Kumar, K.**, Sridhar Babu, B. and Davim, J. P., *Advancements in the Processing, Characterization, and Application of Lightweight Materials*, **IGI Global, USA** (https://www.igi-global.com/book/handbook-research-advancements-processing-characterization/266361)
5. Sridhar Babu, B. and **Kumar, K.**, *Nanomaterials and Nanocomposites: Characterization: Processing, and Applications* (Under book series Engineering Materials) (Catalogue #364177; ISBN: 978-0-367-48389-0, **CRC Press (A Taylor & Francis Company), USA** (https://www.routledge.com/Nanomaterials-and-Nanocomposites-Characterization-Processing-and-Applications/Babu-Kumar/p/book/9780367483890)
6. **Kumar, K.**, Sridhar Babu, B. and Davim, J. P., *Coatings – Materials, Processes, Characterization and Optimization* (Under book series Materials Forming, Machining and Tribology) (978–3–030–62162–9), **Springer Nature, Germany** (https://www.springer.com/gp/book/9783030621629)
7. **Sridhar Babu, B**. Engineering Mechanics **Spectrum publications** 2019.
8. **Sridhar Babu, B**. Engineering Drawing **Spectrum publications** 2019.
9. Kumar, K., **Sridhar Babu, B**. and Davim, J. P., *Optimization for Industrial Problems* (Under Book Series Management Science and Engineering), **River Publishers, DENMARK.**
10. Kumar, K., **Sridhar Babu, B.** and Davim, J. P., *Advanced Welding Engineering and Technology for Marine Applications* (Under Book Series Science, Technology, and Management), **CRC Press (A Taylor & Francis Company), USA.**
11. **Sridhar Babu, B**. Ballistic Performance of Multi- layered metallic plates: FEM **Lambert Publications** 978-3- 659- 92044-8.
12. **Sridhar Babu, B**. Numerical analysis of Ultrasonic machine acoustic horn, **Lambert Publications** 978-3- 659- 93969-3.
13. **Sridhar Babu, B**. Analysis of Honeycomb Sandwich Structures **Lulu Publications** 978-1-365-60830-8.
14. **Sridhar Babu, B**. Analysis of CNC Rotary Table Used in Horizontal Machining Centre **Lulu Publications**
15. Kumar, K., **Sridhar Babu, B.** and Davim, J. P., *Lightweight Materials - Industrial Approach* (Under Book Series Engineering Materials), **CRC Press (A Taylor & Francis Company), USA.**
16. Kumar, K., **Sridhar Babu, B.** and Davim, J. P., *Industrial Automation in I 4.0 Era* (Under book series *Advanced Mechanical Engineering*), **Verlag Walter de Gruyter GmbH, GERMANY.**

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**Book Chapters Published:**

1. Sridhar Babu, B. and **Kumar, K.** *Characterization of Coatings through Indentation technique*. In Kumar, K., Sridhar Babu, B. and Davim, J. P. Eds. Coatings – Materials, Processes, Characterization and Optimization, Springer Nature, Germany Pages 139 – 150 https://doi.org/10.1007/978-3-030-62163-6_6.
2. Ranjan, C., Kalita, H., Sridhar Babu, B. and **Kumar, K.,** *Application of Evolutionary Optimization Techniques Towards Non – Traditional Machining for Performance Enhancement*, In Bose, G. K. and Pain, P. eds. Machine Learning Applications in Non-Conventional Machining Processes, IGI Global USA Pages 181–194 https://doi.org/10.4018/978-1-7998-3624-7.ch011.
3. **Sridhar Babu, B**. Multiaxis CNC programming and machining, Modern manufacturing Processes, Wood head publishing, Elsevier, 2020 **(SCOPUS)**.
4. B. Vijay Kumar and **Sridhar Babu, B**. Optimization of process parameters for AA6063 alloys friction surfacing on Mild steel. Coatings Book, Springer Nature, 2021.
5. Uzawal and **Sridhar Babu, B**. Development and mechanical characterization of jute/polypropylene/coir composites, Plant and Animal Composites Book, De Gruyter 2021.

6. Sateesh Kumar and Sridhar **Babu, B**. A review on ductile attributes of natural fiber composites, Plant and Animal Composites Book, De Gruyter 2021

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**CONFERENCES, WORKSHOPS, SHORT TERM COURSES CONDUCTED:**

1. Convener of 4th International Conference on Manufacturing, Materials Science and Engineering- 2022 (ICMMSE'22), 30 th & 31st December – 2022, SVCET Chittoor, A.P.
2. Program Co-ordinator for AICTE Sponsored Two week Faulty Developmemt Programme on Artificial intelligence for industry 4.0, March 2021
3. Convener of 3rd International Conference on Manufacturing, Materials Science and Engineering- 2021 (ICMMSE'21), 13 th & 14 th August – 2021, CMR Institute Technology.
4. Convener of 2nd International Conference on Manufacturing, Materials Science and Engineering- 2020 (ICMMSE'20), 7th & 8th August – 2020, CMR Institute Technology.
5. Convener of First International Conference on Manufacturing, Materials Science and Engineering - 2019 (ICMMSE'19), 16th –17th August – 2019, CMR Institute Technology, Hyderabad-500090 Telangana, INDIA.
6. Convener of National level Student Symposium (Illuminate 2017), CMR Institute of Technology, Hyderabad.
7. Convener of National level Student Symposium (Illuminate 2016), CMR Institute of Technology, Hyderabad
8. Convener of National level Student Symposium (STANZA & Waves 2006,2007,2008), RRS College of Engineering, Hyderabad.
9. Convener of National Level A two day workshop on Material Characterization, CMR Institute of Technology, Hyderabad.
10. Convener of National Level a two day workshop on Advanced Composite materials, CMR Institute of Technology, Hyderabad.
11. Convener of National Level A two day workshop on Advanced IC Engine Topics, CMR Institute of Technology, Hyderabad.

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**PERSONAL INFORMATION:**

| | |
|---|---|
| Date of Birth | : 08-05-1974 |
| Marital Status | : Married |
| Hobbies | :Playing Cricket, Listening |
| Music. Languages Known | : Telugu, Hindi, and English. |

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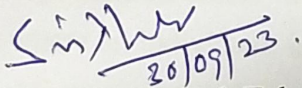
**(Dr. B. Sridhar babu)**

## CERTIFICATE FROM THE INVESTIGATORS

It is certified that

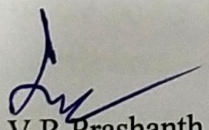
1. We agree to abide by the terms and conditions of the DST grant.
2. We did not submit this or a similar project proposal elsewhere for financial support.
3. We have explored and ensured that equipment and basic facilities available in the host institution and collaborating institution will be used as and when required for the purpose of the project. We shall not require financial support under this project, for procurement of the already available equipment.
4. We undertake that spare time on permanent equipment procured through DST grants will be made available to other users.
5. The proposed equipment is not available with the Host Institution/Collaborating Institution
6. In case the Principal Investigator (PI) leaves the Institution, the Co-Investigator (Co-I) will assume the charge of the Investigator for Competing the Project with prior approval of DST.
7. We understand that shifting of the sanctioned project from one institution to other institution due to change of the institution by the principal investigator/co-investigators is not allowed and is at sole discretion of DST, subject to submission of No Objection Certificate from the Host Institution by the PI.
8. All the information given is true to the best of our knowledge and belief.

1. Signature of Principal-Investigator with place




Dr B Sridhar Babu, Hyderabad, Telengana

2. Signature of Co-Investigator place and date



Dr.I.S.N.V.R.Prashanth, Hyderabad, Telengana

# POLICY ON CONFLICT OF INTEREST

## DEPARTMENT OF SCIENCE AND TECHNOLOGY

Issues of Conflicts of Interest and ethics in scientific research and research management have assumed greater prominence, given the larger share of Government funding in the country's R & D scenario. The following policy pertaining to general aspects of Conflicts of Interest and code of ethics, are objective measures that is intended to protect the integrity of the decision-making processes and minimize biasness. The policy aims to sustain transparency, increase accountability in funding mechanisms and provide assurance to the general public that processes followed in award of grants are fair and non-discriminatory. The Policy aims to avoid all forms of bias by following a system that is fair, transparent and free from all influence/ unprejudiced dealings, prior to, during and subsequent to the currency of the programme to be entered into with a view to enable public to abstain from bribing or any corrupt practice in order to secure the award by providing assurance to them that their competitors will also refrain from bribing and other corrupt practice and the decision makers will commit to prevent corruption, in any form, by their officials by following transparent procedures. This will also ensure a global acceptance of the decision-making process adopted by DST.

**Definition of Conflict of Interest:**

Conflict of Interest means "any interest which could significantly prejudice an individual's objectivity in the decision-making process, thereby creating an unfair competitive advantage for the individual or to the organization which he/she represents". The Conflict of Interest also encompasses situations where an individual, in contravention to the accepted norms and ethics, could exploit his/her obligatory duties for personal benefits.

1. Coverage of the Policy:

(a) The provisions of the policy shall be followed by persons applying for and receiving funding from DST, Reviewers of the proposal and Members of Expert Committees and Programme Advisory Committees. The provisions of the policy will also be applicable on all individuals including Officers of DST connected directly or indirectly or through

intermediaries and Committees involved in evaluation of proposals and subsequent decision-making process.

(b) This policy aims to minimize aspects that may constitute actual Conflict of Interests, apparent Conflict of Interests and potential Conflict of Interests in the funding mechanisms that are presently being operated by DST. The policy also aims to cover, although not limited to, Conflict of interests that are Financial (gains from the outcomes of the proposal or award), Personal (association of relative / Family members) and Institutional (Colleagues, Collaborators, Employer, persons associated in a professional career of an individual such as Ph.D. supervisor etc.)

2. Specifications as to what constitutes Conflict of Interest.

Any of the following specifications (non-exhaustive list) imply Conflict of Interest if,

(i)Due to any reason by which the Reviewer/Committee Member cannot deliver fair and objective assessment of the proposal.

(ii) The applicant is a directly relative# or family member (including but not limited to spouse, child, sibling, parent) or personal friend of the individual involved in the decision-making process or alternatively, if any relative of an Officer directly involved in any decision-making process / has influenced interest/ stake in the applicant's form etc.

(iii) The applicant for the grant/award is an employee or employer of an individual involved in the process as a Reviewer or Committee Member; or if the applicant to the grant/award has had an employer-employee relationship in the past three years with that individual.

(iv) The applicant to the grant/award belongs to the same Department as that of the Reviewer/Committee Member.

(v) The Reviewer/Committee Member is a Head of an Organization from where the applicant is employed.

(vi) The Reviewer /Committee Member is or was, associated in the professional career of the applicant (such as Ph.D. supervisor, Mentor, present Collaborator etc.)

(vii) The Reviewer/Committee Member is involved in the preparation of the research proposal submitted by the applicant.

(viii) The applicant has joint research publications with the Reviewer/Committee Member in the last three years.

(ix) The applicant/Reviewer/Committee Member, in contravention to the accepted norms and ethics followed in scientific research has a direct/indirect financial interest in the outcomes of the proposal.

(x) The Reviewer/Committee Member stands to gain personally should the submitted proposal be accepted or rejected.

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# The Term "Relative" for this purpose would be referred in section 6 of Companies Act, 1956.

1. Regulation:

The DST shall strive to avoid conflict of interest in its funding mechanisms to the maximum extent possible. Self-regulatory mode is however recommended for stake holders involved in scientific research and research management, on issues pertaining to Conflict of Interest and scientific ethics. Any disclosure pertaining to the same must be made voluntarily by the applicant/Reviewer/Committee Member.

2. Confidentiality:

The Reviewers and the Members of the Committee shall safeguard the confidentiality of all discussions and decisions taken during the process and shall refrain from discussing the same with any applicant or a third party, unless the Committee recommends otherwise and records for doing so.

3. Code of Conduct

(a) The applicant must refrain from suggesting referees with potential Conflict of Interest that may arise due to the factors mentioned in the specifications described above in Point No. 2.

(b) The applicant may mention the names of individuals to whom the submitted proposal should not be sent for refereeing, clearly indicating the reasons for the same.

4. Final Appellate authority:

Secretary, DST shall be the appellate authority in issues pertaining to conflict of interest and issues concerning the decision-making process. The decision of Secretary, DST in these issues shall be final and binding.

## DECLARATION

I have read the above "Policy on Conflict of Interest" of the DST applicable to Applicant and agree to abide by provisions thereof.

✓ I hereby declare that I have no conflict of interest of any form pertaining to the proposed grant *

I hereby declare that I have conflict of interest of any form pertaining to the proposed grant*

* (Tick whichever is applicable)

30/09/23

Dr B Sridhar Babu

(Name /Signature with date)

## ENDORSEMENT FROM HEAD OF THE INSTITUTE

1. It is certified that the project proposal "**Structural integrity and Material selection for 3D printed prosthetic sockets: Numerical and Experimental Analysis for paediatric application** as title of the project" has not been submitted to any other agency/agencies for financial support

2. The scale of pay, allowance, etc. proposed are those admissible to persons of corresponding status employed in the Institute/University/NGO/Voluntary Organization, and are in accordance with the DST guidelines

3. It is agreed that any research outcome or intellectual property right(s) on the invention(s) arising out of the project shall be taken in accordance with the instructions issued with the approval of the competent authority.

4. The institute welcomes participation of **Dr B. Sridhar Babu** as the Principal Investigator and ***Dr ISNVR Prasanth*** as the Co-Investigator for the project.

5. In case the Principal Investigator (PI) leaves the Institution, the Co-Investigator (Co-I) will assume the charge of the Principal Investigator for Competing the Project with prior intimation to DST and approval of DST.

6. The Institute will render all administration and financial support for successful completion of the project.

6. The proposed equipment is not available with the Host Institution.

Signature of Executive Authority
of Institute/ University with Seal with date

Principal
Malla Reddy Engineering College
Maisammaguda, Dhulapally,
(Post Via Kompally), Sec'bad-500100.

1. Signature of Principal-Investigator with place and date

30/9/23, Hyderabad.

2. Signature of Co-Investigator place and date

30/9/23 Hyderabad

Malla Reddy Engg. College (A) 500 100

Micro Technologies

**Ref. No:- VIGNAN/MT/2017-2018** **Date: 30 September 2023**

**To,**
**MECH HOD.**

Dear Sir

Sub.:- **Our offer for Laboratory equipments.**

We like to introduce ourselves as a manufacturers and suppliers of Educational Training Equipments and Laboratory products for Engineering Colleges, Polytechnics and other Technical Institutes in India. We have vast experience in manufacturing the educational training systems and laboratory instruments.

We are pleased to enclose herewith our offer and specifications for the MOS Lab Equipments.

We like to bring your kind notice that our products are cost effective and superior in quality. Please feel free to contact us for further queries regarding specifications, pricing and other details.

Please note that we already supplied these equipments to various Engineering colleges in Andhra Pradesh, Orissa, Gujarat and Maharashtra states. We are pleased to enclose herewith our customer list for your kind reference.

We look forward to your favorable consideration.

Thanking you, and hoping to be associated with long-term fruitful basis, we remain,

**Yours truly**
**For Micro Technologies**

**B. RAMA KRISHNA / T. HARI KRISHNA**

Shop No. 25, Anjanadri Block, Seven Hills Apartment, Nizampet Road, Hyderabad - 500 072.
Phone No. 040-23859635, Mobile No. 93951 02571, 93 94003444, 9885757322
E-mail : microtech115@yahoo.com

Micro Technologies

## LAB EQUIPMENTS

| S. No. | Name of the Equipment | Qty. | Amount |
|---|---|---|---|
| 1. | **UNVERSAL TESTING MACHINE- COMPURTERISED VERSION**<br>**10TONS (including extensometer)**<br>UTM with following standard accessories for Tension, compression, Bending & Transverse with auto load facility and generally as per the leaflet enclosed.<br>STANDARD ACCESSORIES: Tension Test 10/25 Tension test jaws for ground specimens 25/40 diameter (mm).<br><br>TENSILE TEST: Tensile Test jaws for flat specimen 0-15 thickness 15-30mm width 65mm.<br><br>COMPRESSION TEST: Pair of compression plates of diameters 20mm.<br><br>TRANSVERSE TEST: Table with adjustable rollers of width (mm) 160 diameter of rollers (mm) 30 maximum clearance between supports (mm) 500 radius of punch<br>Tops (mm) 12 and 16.<br><br>SPECIAL FEATURES FOR COMPUTERISED TESTING:<br>1. Computer controlled with real time graph.<br>2. Results include load Vs displacement curve, max. load max. Displacement, UTS, % elongation, young's modulus & proof stress (if extensometer is used). | 01 No. | **9,50,000.00** |
| 2. | **3D Printer** | 01 | **4,50,000.00** |
| 3. | **PRO E software (1user)** | 01 | **2,50,000** |
| 4. | **Ansys software(1user)** | 01 | **3,50,000** |

Shop No. 25, Anjanadri Block, Seven Hills Apartment, Nizampet Road, Hyderabad - 500 072.
Phone No. 040-23859635, Mobile No. 9395102571, 9490030444, 9885757322
E-mail : microtech115@yahoo.com

Micro Technologies

## TERMS & CONDITIONS

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|---|---|---|---|
| 1. | Taxes & Duties | : | GST @18% on Basic Price |
| 2. | Validity | : | The prices are valid for Two Months |
| 3. | Delivery | : | With in 3 to 4 weeks on receipt of your firm order. |
| 4. | Warranty | : | All our products are warranted against defects in material or workmanship for a period of **TWO** year from date of the delivery. |
| 5. | Payment | : | 40% along with the purchase order and 50% after delivery of the equipment. & Balance After Installation. All payments will be made in the form of DD or cheque. |
| 6. | Installation | : | Above prices are inclusive of Installation and commissioning charges. |
| 7. | Transportation | : | Extra at Actual. |

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