A PROJECT REPORT
ON
"EXOSKELETON ARM"

SUBMITTED To

UNIVERSITY OF MUMBAI

In Partial Fulfilment of the Requirement for the Award of

BACHELOR'S DEGREE IN

MECHANICAL ENGINEERING

BY

KHAN AHRAZ	15DME147	ANSARI HUZEFA	16DME124
KHAN NABEEL	15DME152	SHAIKH YASIN	15ME48
KHAN SALMAN	14ME84	ANSARI AADIL	14ME02
ANSARI SHAHROZ	14ME66	SHAIKH FARHAN	13ME48

UNDER THE GUIDANCE OF

PROF.ARSHAD QURESHI

DEPARTMENT OF MECHANICAL ENGINEERING

Anjuman-i-islam's Kalsekar Technical Campus

SCHOOL OF ENGINEERING & TECHNOLOGY

Plot No. 2 3,Sector -16, Near Thana Naka,

Khandagoan, New Panvel-410206

2018-2019

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CERTIFICATE

This is to certify that project report entitled, "(Exoskeleton Arm)" submitted by Ansari Huzefa ,Ansari Aadil, Shaikh Yasin, Shaikh Farhan, Ansari Shahroz, Khan Ahraz ,Khan Nabeel, Khan Salman in partial fulfillment of the requirement for the award of degree Of Bachelor of Engineering(Mechanical ENGINEERING) at Anjuman-I-Islam Kalsekar Technical Campus, Navi Mumbai under the University Of Mumbai. This work is done during year 2018-19, under our Guidance.

Date: / /

(Prof. Arshad Qureshi)
Guide

(Prof. Rizwan Shaikh)
Project Coordinator

(Prof. Zakir Ansari)
HOD

(DR. Abdul Razak Honnutagi)
Director

ACKNOWLEDGEMENT

We are extremely fortunate to be involved in an exciting and challenging project like "EXOSKELETON ARM". It has enriched our life, giving us an opportunity to work in a field of Design Engineering.

This project increased our thinking and understanding capability and after the completion of this project, we experience the feeling of achievement and satisfaction.

We would like to express our greatest gratitude and respect to our Head of Mechanical Engineering Department Prof. ZAKIR ANSARI , our project guide Prof. ARSHAD QURESHI and project Co-ordinator Prof. SHAKIL TADWI for their excellent guidance, valuable suggestions and endless support. They have not only been a wonderful guide but also a genuine people. We consider ourselves extremely lucky to be able to work under guidance of such a dynamic personalities. Actually they are one of such genuine person for whom our words will not be enough to express.

It was impossible for us to complete our project without their help. We are also grateful to our director, Dr. ABDUL RAZAK HONNUTAGI for their encouragement. We would like to express our thanks to all our classmates, all staffs and faculty members of mechanical engineering department who willingly rendered us their unselfish help and support.

Last but not the least; we want to convey our heartiest gratitude to our parents for their immeasurable love, support and encouragement.

Project Synopsis Approval for B. E.

This project entitled "Exoskeleton Arm" is approved for the degree of Bachelor of Engineering in Department Of Mechanical. Engineering

Examiners

1.---

2.---

Supervisors

1.---

2.---

Chairman

.---

Date:

Place

Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Name of Student

KHAN AHRAZ

KHAN NABEEL

KHAN SALMAN

ANSARI SHAHROZ

ANSARI HUZEFA

SHAIKH YASIN

ANSARI AADIL

SHAIKH FARHAN

INDEX

ABSTRACT

This project deals with movement of an arm by the use of an exoskeleton. an exoskeleton is an external structural mechanism with joints and links corresponding to those of the human body." In other words, designing the kinematics of an exoskeleton generally consists of trying to replicate human limb kinematics. The challenge is to build an exoskeleton system that is inexpensive, streamlined, and wireless. Our solution is unique in that it will be a low-cost, ergonomic device actuated through sensors measuring the user's motion. The exoskeleton arm support system will help the user lift additional weight for day to day activities that the user is not normally able to lift. We have outlined the process of developing an exoskeleton arm which increases the load lifting capacity of a human. The potential applications would be in diverse fields such as defense, physiotherapy and manufacturing. Each year, thousands of workers must take leave due to injuries triggered by heavy lifting; with augmented strength, workers could avoid harmful situations.

Keywords— Pneumatic, Exoskeleton, Arm, Robotic, Lifiting capacity

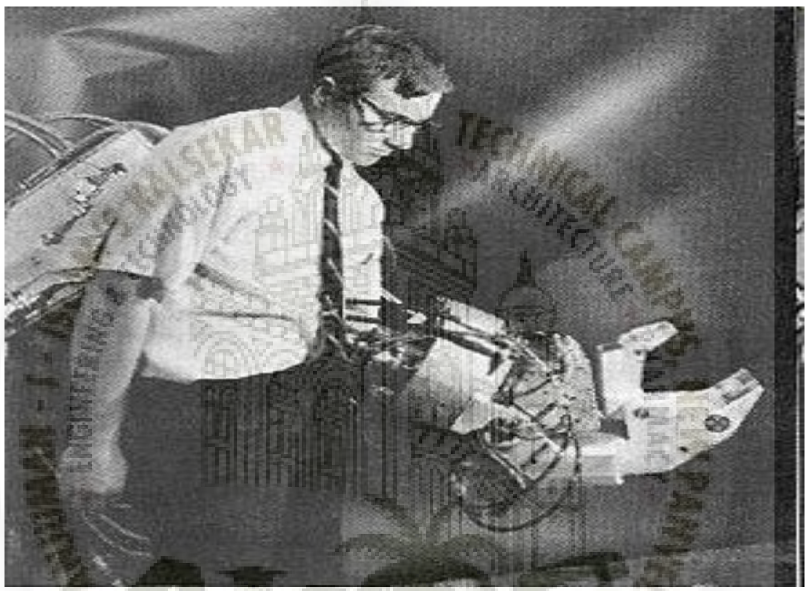
1. INTRODUCTION

One of the proposed main uses for an exoskeleton would be to active upper limb support systems. An exoskeleton is the external skeletal structure that supports or protects the body, in contrast to the internal skeleton (endoskeleton) of a human. The Exoskeleton is a robotic arm that helps muscle movement. Provides an innovative approach to physical therapy in cases of injury and muscle disorders and diseases. Primary users for this design will be people with arm injuries, Myopathy, and Cerebral Palsy. People in need of the device suffer from muscle weakness or loss of movement in a group of muscles. People who could also benefit from the device might also have abnormal movement, tremors or loss of coordination in their upper limbs. The type of myopathy that the device is intended to provide help for is muscular dystrophies. Patients with this type of myopathy have progressive weakness involuntary muscles. Treatment for Myopathy and Cerebral Palsy include physical therapy and bracing to support the affected muscles, surgery and drug therapy. Our design will satisfy the needs for physical therapy and bracing support for treating this disease. The device will need to be lightweight, so that the user is not hindered by the presence of the device. The device should be able to help people with muscular problems perform daily routine activities. The device should help health professionals monitor and record the patient's progress. The device needs to be modular and resizable so that multiple people can use the same device.

1.2 History:

The earliest exoskeleton-like device was a set of walking, jumping and running assisted apparatus developed in 1890 by a Russian named Nicholas Yagin. As a unit, the apparatus used compressed

gas bags to store energy that would assist with movements, although it was passive in operation and required human power.[1] In 1917, United States inventor Leslie C. Kelley developed what he called a pedomotor, which operated on steam power with artificial ligaments acting in parallel to the wearers movements.[2] With the pedomotor, energy could be generated apart from the user.



The first true exoskeleton in the sense of being a mobile machine integrated with human movements was co-developed by General Electric and the United States Armed Forces in the 1960s. The suit was named Hardiman, and made lifting 110 kilograms (250 lb) feel like lifting 4.5 kilograms (10 lb). Powered by hydraulics and electricity, the suit allowed the wearer to amplify their strength by a factor of 25, so that lifting 25 kilograms was as easy as lifting one kilogram without the suit. A feature dubbed force feedback enabled the wearer to feel the forces and objects being manipulated.

Monty Reed, a former Army Ranger who was paralyzed after a night parachute jump went awry, began work on the Lifesuit. While reading Starship Troopers, Reed had the idea for the suit which would allow others who were paralyzed to potentially walk again. The Lifesuit is intended to allow passive movements to the legs which will prevent spasticity. Funding is still needed to allow Reed to test his product out on patients but he refuses to give up his faith

1.3 Applications:

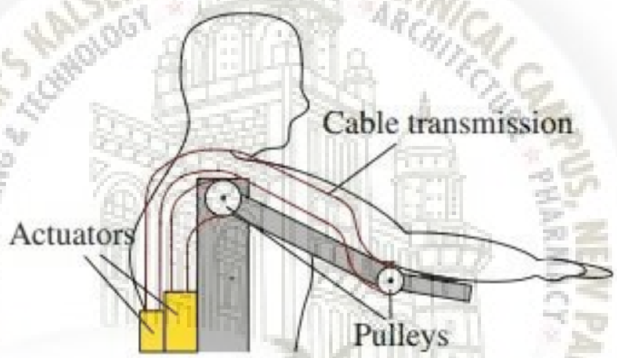
- The advancements of the technology in the Wearable Robots/Exoskeleton field have been booming in the past 5 years.
- These exoskeletons have the potential to be life-altering.
- We once looked at these as being the future, except now it turns out that the future is approaching much more rapidly than we had expected.
- Within the next 5 to 10 years we could possibly see these exoskeletons out on the battlefield helping, as well as, protecting our soldiers.
- Further down the road we could also see robotic surgeons in operating rooms being controlled by surgeons in another room.

- But most likely, even sooner than both of those options, is the potential to see these exoskeletons helping the disabled as well as people with degenerative diseases.
- The potential for this technology seems endless and the effects it will have on the human race will be monumental.

2. LITERATURE REVIEW

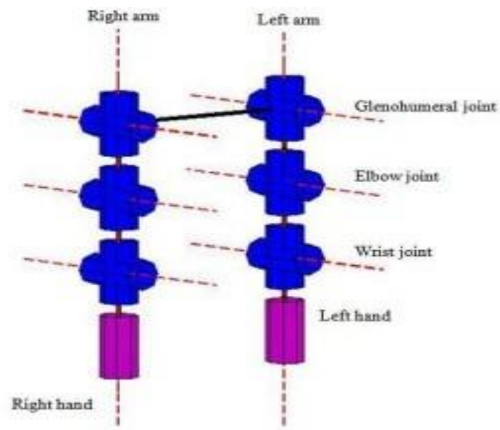
A. E.A. Lomonova et al [1]

Arm support systems provide support throughout daily tasks, training or in an industrial environment. The main objective of this project to analyze the actuation principles in these systems. This actuated arm support systems are classified according to their user environment, Namely: ambulatory, rehabilitation and industrial. The presented arm support systems have been divided based on their applications, actuation technology, and actuator configuration. The actuation principles that are applied in existing arm support systems are electromechanical actuators, pneumatic actuators, hydraulic actuators, and semi-active dampers.



B. Surachai Panich et al [2]

The arm exoskeleton suit was developed to increase human's strength, endurance, or speed enabling them to perform tasks that they previously could not perform. In this project, The kinematic exoskeleton suit for human arms is simulated by MATLAB software. The exoskeleton suit of human arm consists of one link length, three link twists, two link offsets and three joint angles. This project is used to increase the strength of human that can lift heavy load or help handicapped patients, who cannot use their arm.This project can be applied in industry application to move or lift the load in the area, in where the vehicles or crane cannot use. This exoskeleton should be designed to have more DOF. It will increase the complexity and flexible motion like human arm.



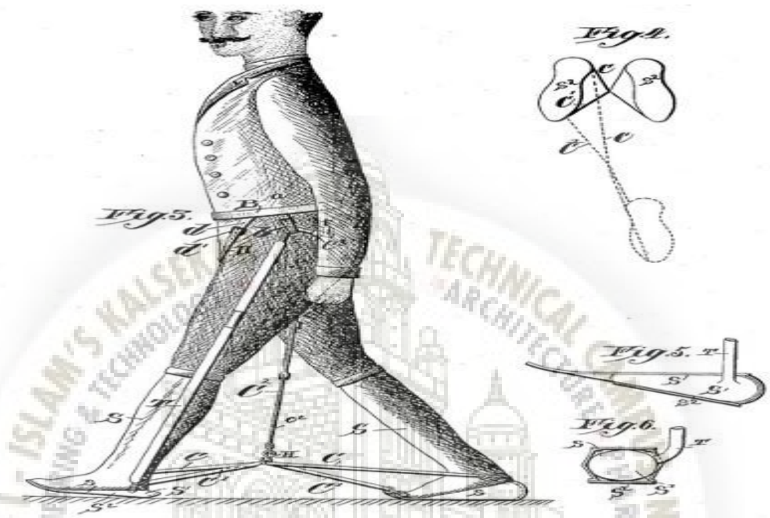
. 1: Link kinematic of exoskeleton suit for human

C. Sheeba P. S et al [3]

The main objective for this paper to enhance and the assist of natural upper body motion of the human skeleton.In this project pneumatic air muscles (PAMs) are used. The PAM has a thin-walled, rubber bladder placed inside an axially stiff but radially compliant braided sleeve. This powered exoskeleton enables a human to perform tasks which are beyond the physical prowess by amplifying the muscular movement.In this project, power assist type exoskeleton has been selected rather than a more expensive power amplification device. The use of EMG electrodes as proposedin this project will enable people with muscular defects to still be able to perform daily tasks like a fully functional human.

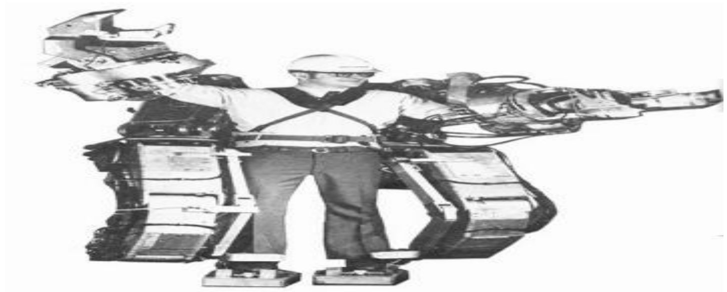
D. Nicholas Yagn

He has invented the first exoskeleton structure to assist walking, jumping and running. It contained compressed gas bags to power it.In this project power amplification device was used. This model gave users better mobility and reduced the strain of running and jumping.



E. General Electric in association with United States Military

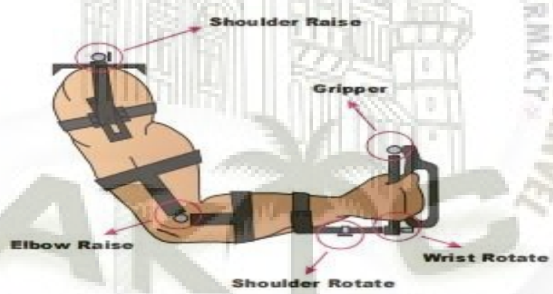
Company has developed the first totally functional and powerful exosuit. This model was able to lift110kg with effort reduction by the factor of 10. It was designed to amplify a user's strength substantially, but its designer never completely nailed down the controls and power requirements.they named this model as Hardiman.The main problem in Hardiman was man-machine interface problem due to the complexity of the multi-jointed system and the intimate coupling of the man and machine imposed many design constraints and made heavy demands on existing technology.



F. Rhyan Andrad et al [6]

He has developed an exoskeleton controller for a prototype robotic arm, which is stand-alone, portable, programmable, and easy to maintain and use.

The product of this project can become a basis for future exoskeleton controller designs.The main objectives of this project are to stand-alone, meaning it should be independent on any computer to perform its tasks; 2) It should portable, meaning it should be small and light enough to be carried anywhere and plugged into any power source; 3)It should programmable, meaning it should provide an option for the users to record a series of actions and 4)It should user-friendly, meaning it should be comfortable enough to wear, easy to use, understand, and maintain.This project does not involve high accuracy movement translations nor any study on the speed of response of the robot arm,this are the drawbacks of this project.



3. PROBLEM DEFINITION

3.1 PROBLEM DEFINITION

The key object of this research is to reduce work load of physiotherapist. Therefore, this robot arm can rotate cover the range of - 90 to 90 degrees for each joint. Hence, it covers the range of human joint's motion. The arm can be configured by rotating joint 2 to 180 degrees for the use of right or left arm. This exoskeleton arm can be utilized for rehabilitation and training purposes.

3.2 Aim of the Project

- ✓ Provides an innovative approach to active upper limb support systems.
- ✓ Provides an innovative approach to physical therapy in cases of injury and muscle disorders and diseases.
- ✓ Primary users for this design will be people with arm injuries, Myopathy, and Cerebral Palsy.
- ✓ People in need of the device suffer from muscle weakness or loss of movement in a group of muscles.
- ✓ People who could also benefit from the device might also have abnormal movement, tremors or loss of coordination in their upper limbs.
- ✓ The type of myopathy that the device is intended to provide help for is muscular dystrophies. Patients with this type of myopathy have progressive weakness involuntary muscles.
- ✓ Treatment for Myopathy and Cerebral Palsy include physical therapy and bracing to support the affected muscles, surgery and drug therapy. Our design will satisfy the needs for physical therapy and bracing support for treating this disease.
- ✓ The device will need to be lightweight, so that the user is not hindered by the presence of the device.
- ✓ The device should be able to help people with muscular problems perform daily routine activities.
- ✓ The device should help health professionals monitor and record the patient's progress.

4. PLAN OF ACTION

A). Current Status of Development:

1. Design and prototype development is planned.
2. Material selection and cad drawing is work in progress.

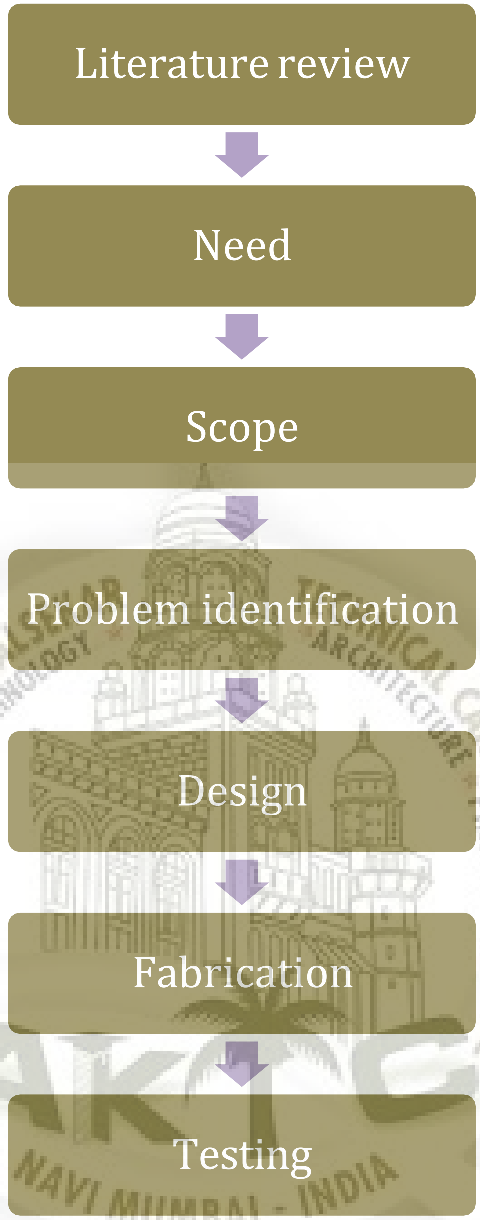
B). Time Frame required for various states of project Implementation:

Sr. No.	Phases	Time Duration.
1.	Materials/ Components requirement specifications.	3 Weeks
2.	System Design.	2 Weeks
3.	Arm Fabrication and Trial	4-6 Weeks
4.	Implementation	5 Weeks
5.	Testing	1 Week

As per time frame required for various states of project Implementation:

Our expected project completion will be around in the month of Feb 2018.

5. METHODOLOGY



5.1 EXO SKELETON ARM WORKING:

Rehabilitation robots have become important tools in stroke rehabilitation. Compared to manual arm training, robot-supported training can be more intensive, of longer duration and more repetitive. The Exoskeleton is a robotic arm that assists muscle movement. It is an outer framework that can be worn on a biological arm It is uses a Non-invasive method to acquire muscles to control the framework, that can be worn on a biological arm. it is Powered by a high torque servo motor. It Can provide assistance or increase the strength of the biological arm, depending on the torque of the servo motor.

MATERIAL SELECTION

The proper selection of material for the different part of a machine is the main objective in the fabrication of machine. For a design engineer it is must that he be familiar with the effect, which the manufacturing process and heat treatment have on the properties of materials. The Choice of material for engineering purposes depends upon the following factors:

1. Availability of the materials.
2. Suitability of materials for the working condition in service.
3. The cost of materials.
4. Physical and chemical properties of material.
5. Mechanical properties of material.

The mechanical properties of the metals are those, which are associated with the ability of the material to resist mechanical forces and load. We shall now discuss these properties as follows:

1. Strength : It is the ability of a material to resist the externally applied forces
2. Stress: Without breaking or yielding. The internal resistance offered by a part to an externally applied force is called stress.
3. Stiffness: It is the ability of material to resist deformation under stresses. The modules of elasticity of the measure of stiffness.
4. Elasticity: It is the property of a material to regain its original shape after deformation when the external forces are removed. This property is desirable
5. for material used in tools and machines. It may be noted that steel is more elastic than rubber

.

6. Plasticity: It is the property of a material, which retain the deformation produced under load permanently. This property of material is necessary for forging, in stamping images on coins and in ornamental work.
7. Ductility: It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. The ductility is usually measured by the terms, percentage elongation and percent reduction in area. The ductile materials commonly used in engineering practice are mild steel, copper, aluminum, nickel, zinc, tin and lead.
8. Brittleness: It is the property of material opposite to ductile. It is the property of breaking of a material with little permanent distortion. Brittle materials when subjected to tensile loads snap off without giving any sensible elongation. Cast iron is a brittle material.
9. Malleability: It is a special case of ductility, which permits material to be rolled or hammered into thin sheets, a malleable material should be plastic but it is not essential to be so strong. The malleable materials commonly used in engineering practice are lead, soft steel, wrought iron, copper and aluminum.
10. Toughness: It is the property of a material to resist the fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. It is measured by the amount of absorbed after being stressed up to the point of fracture. This property is desirable in parts subjected to shock an impact loads.
11. Resilience: It is the property of a material to absorb energy and to resist rock and impact loads. It is measured by amount of energy absorbed per unit volume within elastic limit. This property is essential for spring material.

12.Creep: When a part is subjected to a constant stress at high temperature for long period of time, it will undergo a slow and permanent deformation called creep. This property is considered in designing internal combustion engines, boilers and turbines.

13.Hardness: It is a very important property of the metals and has a wide verity of meanings. It embraces many different properties such as resistance to wear scratching, deformation and mach inability etc. It also means the ability of the metal to cut another metal. The hardness is usually expressed in numbers, which are dependent on the method of making the test. The hardness of a metal may be determined by the following test.

a) Brinell hardness test
b) Rockwell hardness test
c) Vickers hardness (also called diamond pyramid) test and
d) Share scaleroscope.

The science of the metal is a specialized and although it overflows in to realms of knowledge it tends to shut away from the general reader. The knowledge of materials and their properties is of great significance for a design engineer. The machine elements should be made of such a material which has properties suitable for the conditions of operations. In addition to this a design engineer must be familiar with the manufacturing processes and the heat treatments have on the properties of the materials. In designing the various part of the machine it is necessary to know how the material will function in service. For this certain characteristics or mechanical properties mostly used in mechanical engineering practice are commonly determined from standard tensile tests. In engineering practice, the machine parts are subjected to various forces, which may be due to either one or more of the following.

1. Energy transmitted
2. Weight of machine
3. Frictional resistance
4. Inertia of reciprocating parts
5. Change of temperature
6. Lack of balance of moving parts

The selection of the materials depends upon the various types of stresses that are set up during operation. The material selected should with stand it. Another criteria for selection of metal depend upon the type of load because a machine part resist load more easily than a live load and live load more easily than a shock load.

Selection of the material depends upon factor of safety, which in turn depends upon the following factors.

1. Reliabilities of properties
2. Reliability of applied load
3. The certainty as to exact mode of failure
4. The extent of simplifying assumptions
5. The extent of localized
6. The extent of initial stresses set up during manufacturing
7. The extent loss of life if failure occurs
8. The extent of loss of property if failure occurs

Materials selected in m/c

Base plate, motor support, sleeve and shaft

Material used

7. Mild steel

Reasons:

1. Mild steel is readily available in market
2. It is economical to use
3. It is available in standard sizes
4. It has good mechanical properties i.e. it is easily machinable
5. It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure
6. It has high tensile strength
7. Low co-efficient of thermal expansion

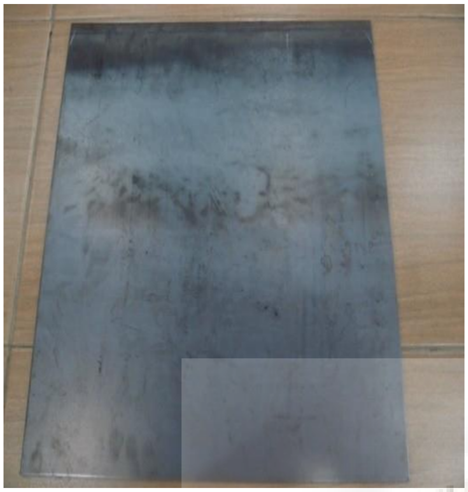
Properties of Mild Steel:

M.S. has a carbon content from 0.15% to 0.30%. They are easily wieldable thus can be hardened only. T

hey are similar to wrought iron in properties. Both ultimate tensile and compressive strength of these steel increases with increasing carbon content. They can be easily gas welded or electric or arc welded. With increase in the carbon percentage weld ability decreases.

Mild steel serve the purpose and was hence was selected because of the above purpose

3.1.2 TOOLS

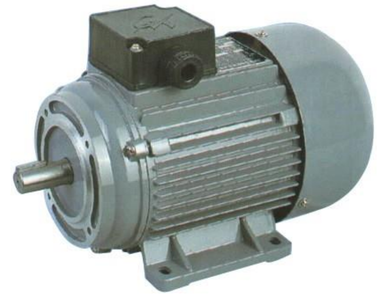


Mild Steel plate

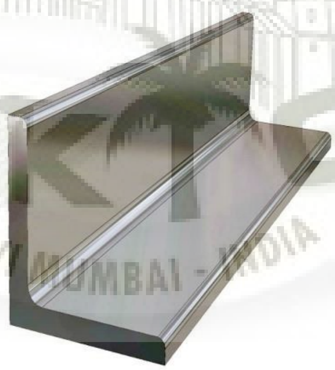
Steel plate cutter

Welding machine

Lathe Machine



Drill machine Electric motor



Iron angles

Steel file tool

measuring tape

Vices

Cutting shearing pliers

EN 10083 C45 steel carbon steel

C45 steel sheet Physico-chemical testing items for products of the plant include tensile test ,hardness test ,impact test ,flattening test ,and chemical composition analysis ,etc .C20,C45 steel pipes are manufactured by cold drawn process.

C45 is a medium carbon steel is used when greater strength and hardness is desired than in the "as rolled" condition. Extreme size accuracy, straightness and concentricity combine to minimize wear in high speed applications. Turned, ground and polished.

Soft Annealing

Heat to 680-710oC, cool slowly in furnace. This will produce a maximum Brinell hardness of 207.

Normalizing

Normalizing temperature: 840-880oC/air.

Hardening

Harden from a temperature of 820-860oC followed by water or oil quenching.

Tempering

Tempering temperature: 550-660oC/air.

C45 steel plate, EN 10083 C45 steel plate, under EN 10083 standard, we can regard C45 steel plate as high carbon steel.

C45 steel plate is one mainly of high carbon steel,EN 10083 C45 steel plate is for quenching and tempering. Technical delivery conditions for non alloy steels,these steels are for general engineering purposes

	Comparision of steel grades	
C45 EN 10083-2 Number:1.0503	JIS G 4051	S 45 C
	DIN 17200	C 45
	NFA 33-101	AF65-C 45
	UNI 7846	C 45
	BS 970	070 M 46
	UNE 36011	C 45 k
	SAE J 403-AISI	1042/1045

Chemical Composition of EN C45 steel

Grade	C(%)min-max	Si(%)min-Max	Mn(%)min-max	P(%)max	S(%)max	Cr(%)min-max
C45	0.42-0.50	0.15-0.35	0.50-0.80	0.025	0.025	0.20-0.40

Mechanical Properties of EN C45 steel

Grade	Condition	Yield Strength R°(Mpa)	Tensile Strength Rm (Mpa)	Elon-gation A5(%)	Hardness HRC	Quenching Temperature (℃)	Benda-bility	Nominal Thickness,t 1.95mm≤t≤10.0 mm	
								Rolled	Annealed

C45	Rolled Annealed Water-quenched Oil quenched	460 330	750 540 2270 1980	18 30	58 55	820 860	Min.reco-mmended Bending radius (≤90°)	2.0 ×t	1.0×t

Properties of steel C45 (1.0503) Properties of steel C45 (1.0503)

Weldability: Due to the medium-high carbon content it can be welded with some precautions.

Hardenability: It has a low hardenability in water or oil; fit for surface hardening that gives this steel grade a high hardness of the hardened shell.

Product Information

ITEMS INFO

SPECIFICATION FOR OPTION:

Round bar	Diameter: 4mm~800mm or as required
Steel plate	Thick:8mm~300mm, Width:100mm~2300mm
Angle bar	Size:3mm*20mm*20mm~12mm*800mm*800mm
Square bar	Size: 4mm*4mm~100mm*100mm
	Width:10mm~2000mm
Hexagonal	Size: 4mm~800mm
Length: 2m,4m,5.8m,6m,11.8m,12m or as required	

MECHANICAL PROPERTY:

Annealing	Forging	Tempering and Hardening	Normalization
Subcritical annealing: 650~700	1100~850	Tempering: 550~660	840~880
Isothermal annealing: 820~860		Hardening : 820~860 water	

CHEMICAL COMPOSITION:

NO.	C	Mn	Si	Cr	Cu	Ni	P	S
Aisi 1045	0.43~0.50	0.6~0.9	0.10~0.60				≤0.040	≤ 0.050
DIN1.1191	0.42~0.48	0.6~0.9	0.15~0.35	≤0.15	≤0.3	≤0.2		
JIS S45C	0.42~0.50	0.5~0.8	≤0.40	≤0.40		≤ 0.4		
C45	0.42-0.50	0.5~0.8	0.4~0.8				≤0.035	≤0.035
GB45	0.42~0.50	0.5~0.8	0.17~0.37	≤0.25	≤0.25	≤0.3	≤0.035	≤0.035
EN8	0.42~0.48	0.6~0.9	0.15~0.35	≤0.20	≤0.30	≤0.20	≤0.030	≤0.030

Why Mild steel C-45 is selected in our project.

1. Easily available in all sections.
2. Welding ability
3. Machinability
4. Cuttingablity
5. Cheapest in all other metals.

Material = C 45 (mild steel)

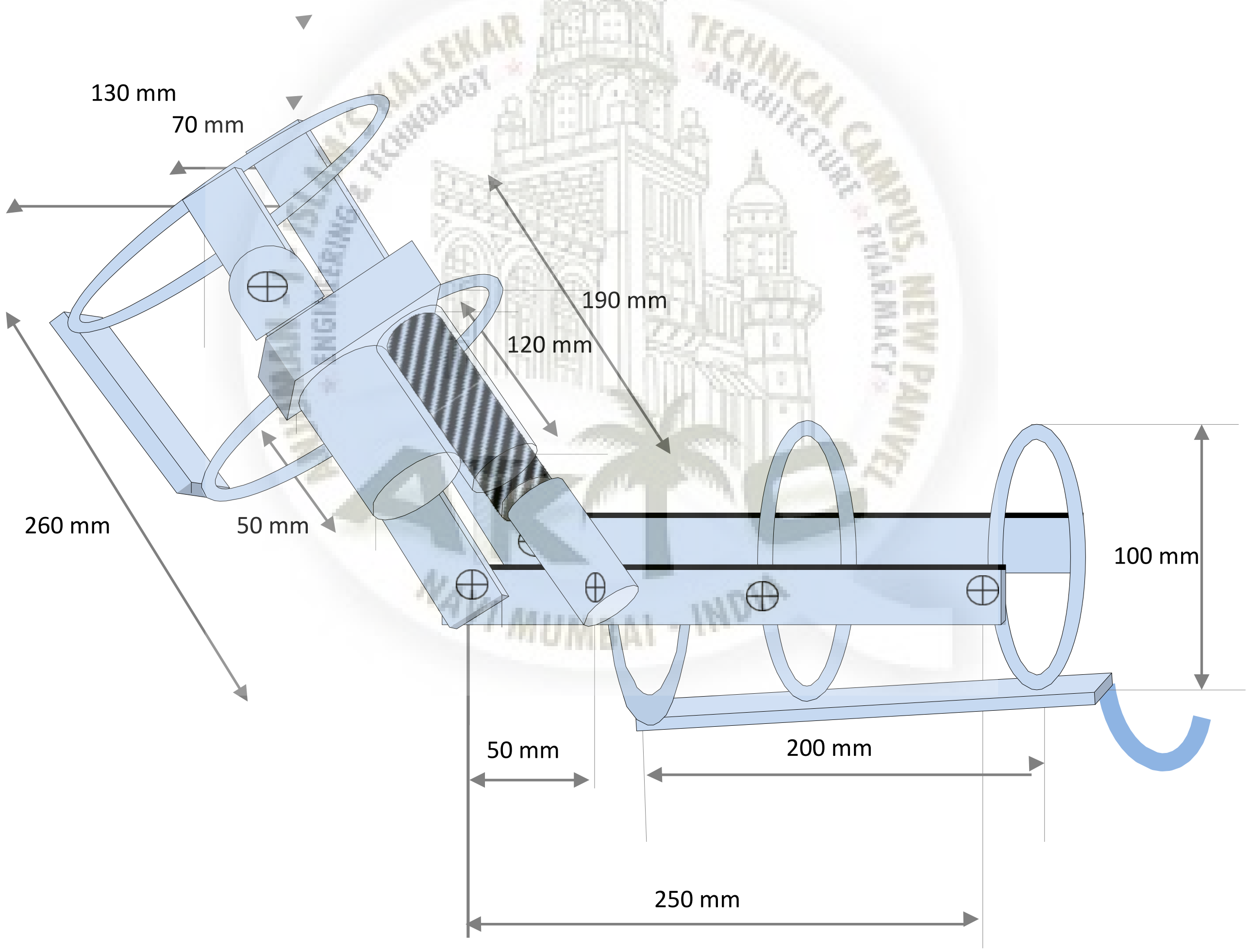
Take fos 3

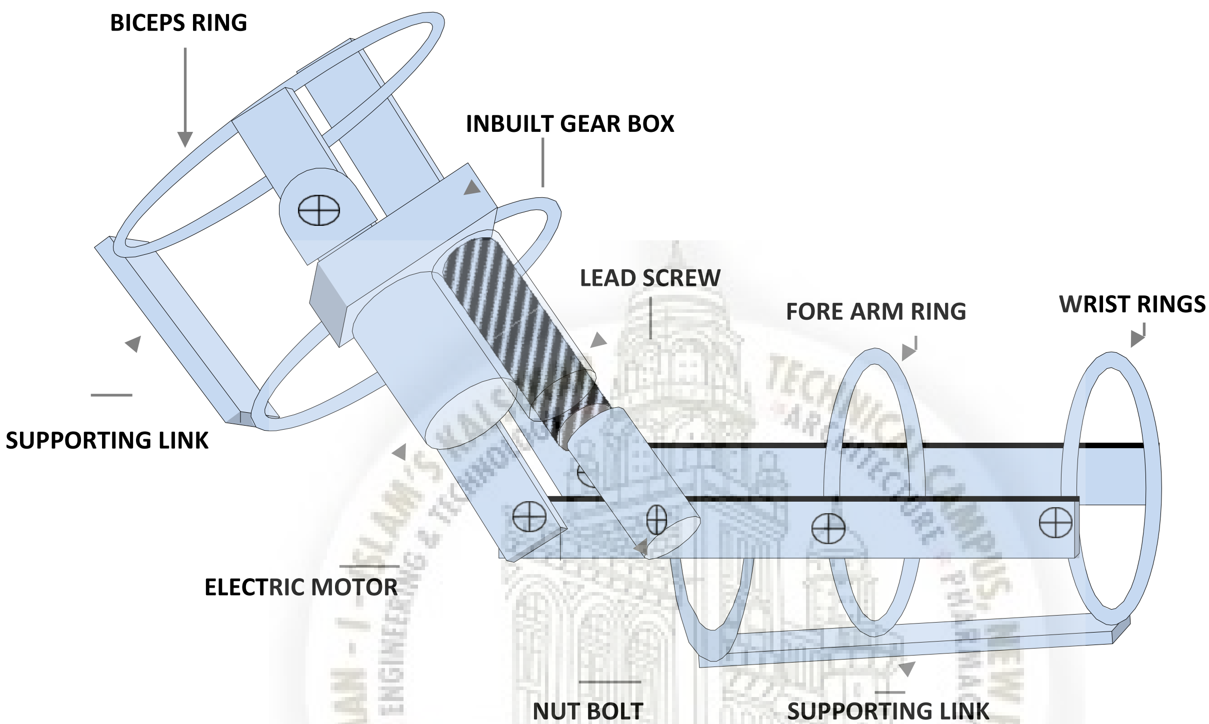
$\sigma_t = \sigma_b = 540/fos = 180$ N/mm^2

$$\sigma_s = 0.5\ \sigma_t$$

$$= 0.5 \times 180$$

$$= 90\ N/mm^2$$




BICEPS RING
INBUILT GEAR BOX
LEAD SCREW
FORE ARM RING
WRIST RINGS
SUPPORTING LINK
ELECTRIC MOTOR
NUT BOLT
SUPPORTING LINK

MACHINE DESIGN

The subject of MACHINE DESIGN deals with the art of designing machine of structure. A machine is a combination of resistance bodies with successfully constrained relative motions which is used for transforming other forms of energy into mechanical energy or transmitting and modifying available design is to create new and better machines or structures and improving the existing ones such that it will convert and control motions either with or without transmitting power. It is the practical application of machinery to the design and construction of machine and structure. In order to design simple component satisfactorily, a sound knowledge of applied science is essential. In addition, strength and properties of materials including some metrological are of prime importance. Knowledge of theory of machine and other branch of applied mechanics is also required in order to know the velocity. Acceleration and inertia force of the various links in motion, mechanics of machinery involve the design.

CONCEPT IN M.D.P.

Consideration in Machine Design

When a machine is to be designed the following points to be considered: -

i) Types of load and stresses caused by the load.

ii) Motion of the parts and kinematics of machine. This deals with the type of motion i.e. reciprocating . Rotary and oscillatory.

iii) Selection of material & factors like strength, durability, weight, corrosion resistant, weld ability, machine ability are considered.

iv) Form and size of the components.

v) Frictional resistances and ease of lubrication.

vi) Convince and economical in operation.

vii) Use of standard parts.

viii) Facilities available for manufacturing.

ix) Cost of making the machine.

x) Number of machine or product are manufactured.

GENERAL PROCEDURE IN MACHINE DESIGN

The general steps to be followed in designing the machine are as followed.

i) Preparation of a statement of the problem indicating the purpose of the machine.

ii) Selection of groups of mechanism for the desire motion.

iii) Calculation of the force and energy on each machine member.

iv) Selection of material.

v) Determining the size of component drawing and sending for manufacture.

vi) Preparation of component drawing and sending for manufacture.

vii) Manufacturing and assembling the machine.

viii) Testing of the machine and for functioning.

ix) Preparation of a statement of the problem indicating the purpose of the machine.

x) Selection of groups of mechanism for the desire motion.

xi) Calculation of the force and energy on each machine member.

xii) Selection of material.

xiii) Determining the size of component drawing and sending for manufacture.

xiv) Preparation of component drawing and sending for manufacture.

xv) Manufacturing and assembling the machine.

xvi) Testing of the machine and for functioning.

CALCULATION

The linear actuator we will purchase will be of 150 lbs = 68 kg

L1 = 50 mm

L2 = 250 mm

F1 x L1 = F2 x L2

68 x 50 = F2 x 250

F2 = 3400/250

F2 = 1200/300 = 13.6 kg

By changing L1 we can increase or decrease the speed of arm going up and down. Also weight carrying capacity can be change

MOTOR SPECIFICATION

P = 20 WATTS

VOTAGE = 12V

CAPACITY = 150 lbs

GEARING RATIO = 1:20

For taking weight of each components

Cross-Sectional size of link used is 18x4 mm

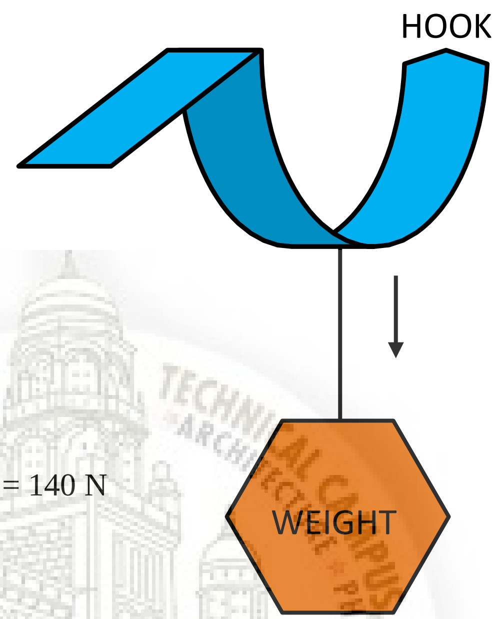
Representation of M.S. Flats is done by the Width (W) & the Thickness (T) of the Flat.

Weight (Kg/mtr)

Size (mm)	Weight (kg/ft)	Weight (Kg/mtr)
12 x 3	0.086	0.282
12 x 5	0.143	0.470
18 x 4	0.180	0.585
20 x 3	0.143	0.470
20 x 5	0.241	0.790

Design of hook

This hook may fail under bending, it is made up of MS flat 18 x 4 size.

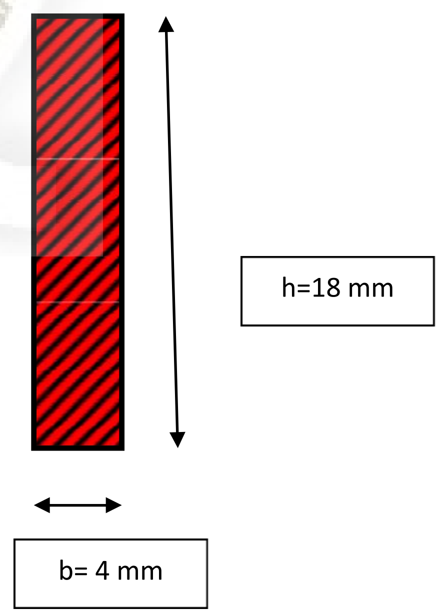


F = maximum force to be lifted by hook = 140 N

For cantilever, M = F x L

M = 140 x 40 = 5600 N-mm

And section modulus = Z = 1/6 bh^2



$Z = 1/6 \times 4 \times 18^2$

$Z = 1/6 \times 1296$

$Z = 216\ mm^3$.

Now using the relation,

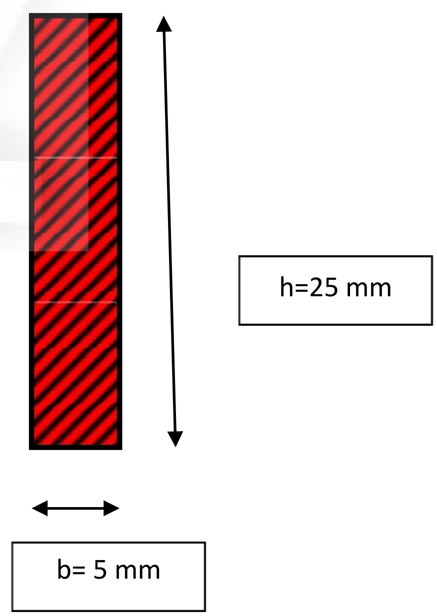
Fb = M / Z

Fb= 5600/ 216 = 25.9 N/mm^2

Indused stress is less then allowable so design is safe

Design of transverse fillet welded joint.

Hence, selecting weld rod size = 3.2mm



Area of Weld = 0.707 x Weld Size x L

= 0.707 x 3.2 x 25

= 56.56 mm^2

Force exerted = ---N

Stress induced = Force Exerted / Area of Weld

21 = F / 56.56

F= 1187.76 N = 121.07 kg

Maximum Allowable Stress for Welded Joints = 21 N/mm^2

Design of bolt:-

Bolt is to be fastened tightly also it will take load due to rotation. Stress for C-45 steel ft =420 kg/cm^2 . Std nominal diameter of bolt is 9.31 mm. From table in design data book, diameter corresponding to M10 bolt is 8 mm

Let us check the strength :-

Also initial tension in the bolt when belt is fully tightened.

P = 981 N is the value of force

P = 981 N

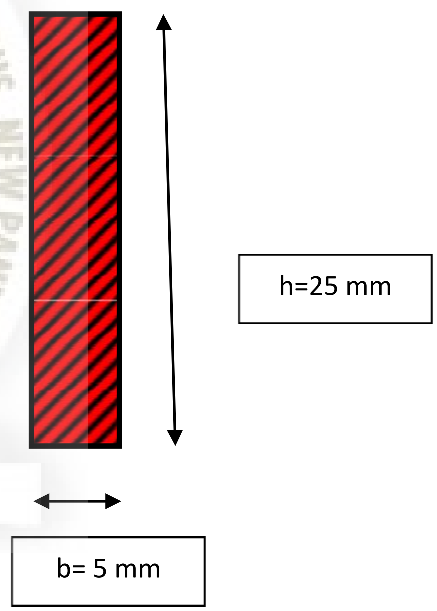
Also, P = Π /4 dc^{2}x σ

$$\sigma = \frac{981 \times 4}{3.14 \times (8)^2} = 3924/201 = 19.51 \text{ N / mm}^2$$

the calculated σ is less than the $\sigma_{tensile}$ and σ_{shear} hence our design is safe.

Design of transverse fillet welded joint.

Hence, selecting weld rod size = 3.2mm



Area of Weld = 0.707 x Weld Size x L

= 0.707 x 3.2 x 25

= 56.56 mm^2

Force exerted = ---N

Stress induced = Force Exerted / Area of Weld

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F= 1187.76 N = 121.07 kg

Maximum Allowable Stress for Welded Joints = 21 N/mm^2

`

Design of bolt:- tension

Bolt is to be fastened tightly also it will take load due to rotation. Stress for C-45 steel ft =420 kg/cm^2 . Std nominal diameter of bolt is 9.31 mm. From table in design data book, diameter corresponding to M10 bolt is 8 mm

Let us check the strength :-

Also initial tension in the bolt when belt is fully tightened.

P = 981 N is the value of force

P = 981 N

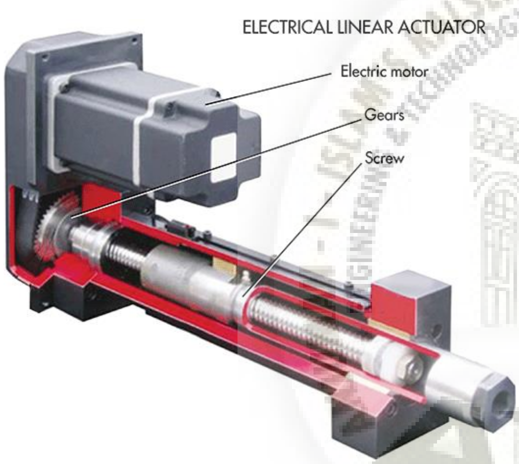
Also, P = Π /4 dc^{2}x ft

$$ft = \frac{981 \times 4}{3.14 \times (8)^2} = 3924/201 = 19.51 \text{ N / mm}^2$$

the calculated ft is less than the maximum ft hence our design is safe.$\sigma_t = \sigma_b$= 135 N/mm^2 σ_s = 67.5 N/mm^2

5.2 PARTS:

1. ELECTRIC LINIEAR ACTUATOR MOTOR :



This simple electrical actuator system will ensure consistent operation in both directions. It will also give you added features such as end of stroke limit switches, mid stroke protection and manual override operation in case of power failure. Optional features such as analog or digital position feedback and adjustable end of stroke limit switches are also available. Another advantage is that a system like this is easy to integrate with other control systems normally found in industrial systems or vehicles such as PLC’s, micro-controllers, computers or simple relay based systems.

2. HAND CAGE:

It is a mild steel structure inside which human hand will go and will support the mounting of linear actuator and all mechanism for project. The material used will be mild steel C-45 because of it good properties like weld ability, cutting ability, machine ability, easily available in all section and cheapest in all other metals.

3. BATTERY:

In this project we will use 12volt and 7.5 amp lead acid dry battery. The lead–acid battery was invented in 1859 by French physicist Gaston Planté and is the oldest type of rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, its ability to supply high surge currents means that the cells have a relatively large power-to-weight ratio. These features, along with their low cost, make them attractive for use in motor vehicles to provide the high current required by automobile starter motors.

4. SWITCH:

The Forward & Reverse Switch is an equally important and convenient device in the direction selector that controls the forward and reverse motion of Electric equipments. It's ease of use contributes to the smooth operation and handling of your vehicle. This item is best used on vehicles with a Precision Drive System (PDS) controller.

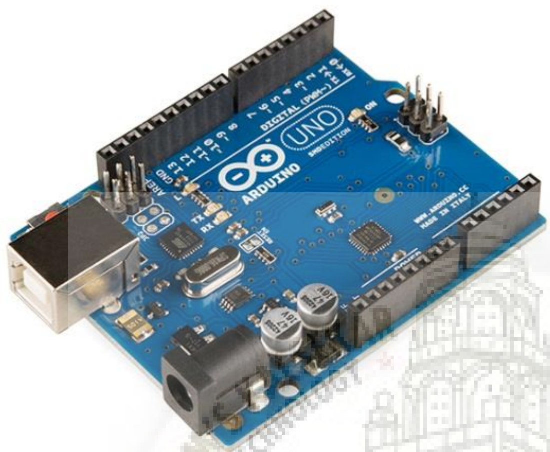
4. NITRILE RUBBER INSULATION:

In four stroke the "Poppet Valve" performs the opening of the cylinder to inlet or exhaust manifold at the correct moment. Generally there is same angle of face in inlet and exhaust valve of same engines. To make it in right order, generally the face of valve is ground at 45 degree but in same cases it is ground at 30 degree also.

5.3 POP RIVIT:

A rivet is a permanent mechanical fastener. Before being installed, a rivet consists of a smooth cylindrical shaft with a head on one end. The end opposite to the head is called the tail. On installation, the rivet is placed in a punched or drilled hole, and the tail is upset, or bucked (i.e., deformed), so that it expands to about 1.5 times the original shaft diameter, holding the rivet in place. In other words, pounding creates a new "head" on the other end by smashing the "tail" material flatter, resulting in a rivet that is roughly a dumbbell shape. To distinguish between the two ends of the rivet, the original head is called the factory head and the deformed end is called the shop head or buck-tail.

5.4 Arduino Uno



The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0.The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform.The ATmega328 on the Arduino Uno comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol.The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

MUSCLE SENSORS

Measuring muscle activation via electric potential, referred to as electromyography (EMG), has traditionally been used for medical research and diagnosis of neuromuscular disorders. However, with the advent of ever shrinking yet more powerful microcontrollers and integrated circuits, EMG circuits and sensors have found their way into prosthetics, robotics and other control systems.

Three-lead Differential Muscle/Electromyography Sensor for Microcontroller Applications FEATURES

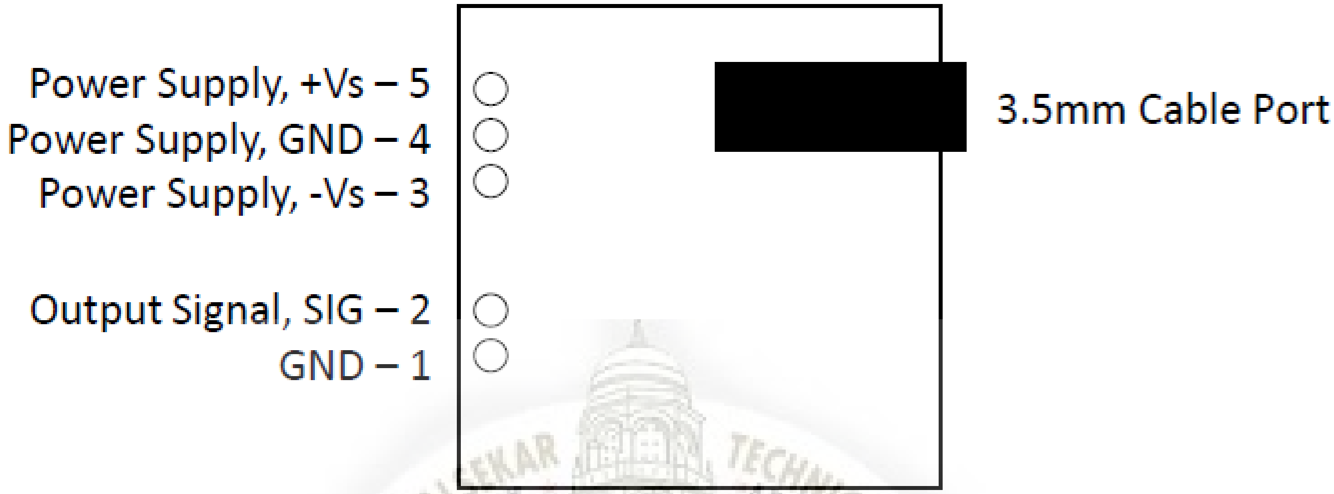
- Small Form Factor (1inch X 1inch)
- Specially Designed For Microcontrollers
- Adjustable Gain – Improved Ruggedness
- New On-board 3.5mm Cable Port
- Pins Fit Easily on Standard Breadboards

Muscle Sensor v3 APPLICATIONS

- Video games
- Robots
- Medical Devices
- Wearable/Mobile Electronics
- Powered Exoskeleton suits

Output Signal, SIG – 2
GND – 1

Power Supply, +Vs – 5
Power Supply, GND – 4
Power Supply, -Vs – 3 PIN LAYOUT



What is electromyography?

Measuring muscle activation via electric potential, referred to as electromyography (EMG), has traditionally been used for medical research and diagnosis of neuromuscular disorders. However, with the advent of ever shrinking yet more powerful microcontrollers and integrated circuits, EMG circuits and sensors have found their way into prosthetics, robotics and other control systems

Getting Started Using Two 9V Batteries

1)Connect the power supply (two 9V batteries)

a.Connect the positive terminal of the first 9V battery to the +Vs pin on your sensor.

b.Connect the negative terminal of the first 9V battery to the positive terminal of the second 9V battery. Then connect to the GND pin on your sensor.

c.Connect the negative terminal of the second 9V battery to the –Vs pin of your sensor.

2)Connect the electrodes

a.After determining which muscle group you want to target (e.g. bicep, forearm, calf), clean the skin thoroughly.

b.Place one electrode in the middle of the muscle body, connect this electrode to the RED Cable's snap connector.

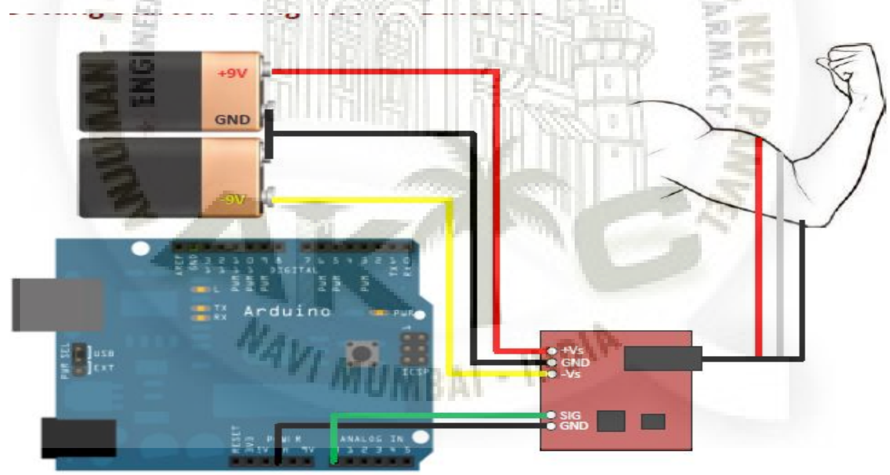
c.Place a second electrode at one end of the muscle body, connect this electrode to the Blue Cable's snap connector.

d.Place a third electrode on a bony or non-muscular part of your body near the targeted muscle, connect this electrode to the Black Cable's snap connector.

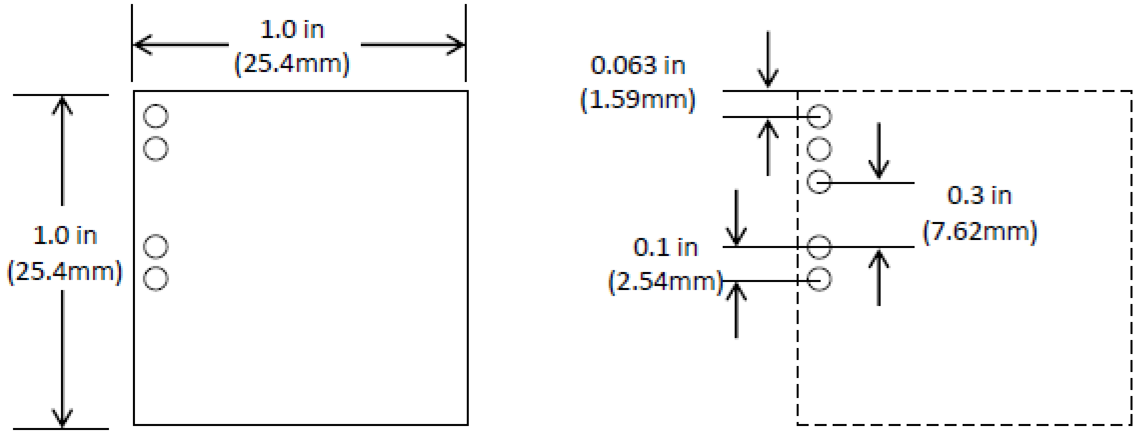
3)Connect to a Microcontroller (e.g. Arduino)

a.Connect the SIG pin of your sensor to an analog pin on the Arduino (e.g. A0)

b.Connect the GND pin of your sensor to a GND pin on the Arduino.



Dimensions



Electrical Specifications

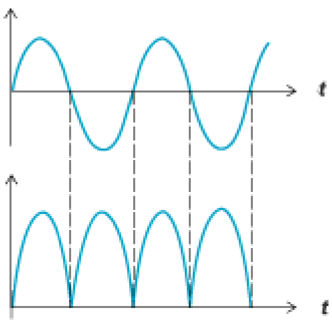
Parameter	Min	TYP	Max
Power Supply Voltage (Vs)	±3.5V	±5V	±18V
Gain Setting, Gain = 207*(X /1 kΩ)	0.01 Ω (0.002x)	50 kΩ (10,350x)	100 kΩ (20,700x)
Output Signal Voltage (Rectified & Smoothed)	0V	--	+Vs
Differential Input Voltage	0 mV	2-5mV	+Vs/Gain

ELECTROSTATIC DISCHARGE SENSITIVITY

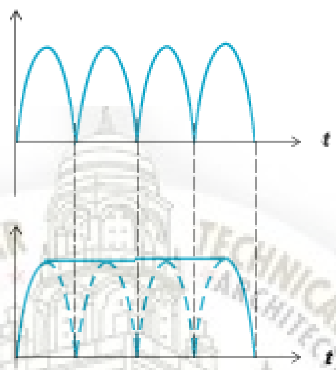
This sensor can be damaged by ESD. Advancer Technologies recommends that all sensors be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure

RAW EMG vs Rectified & Smoothed EMG

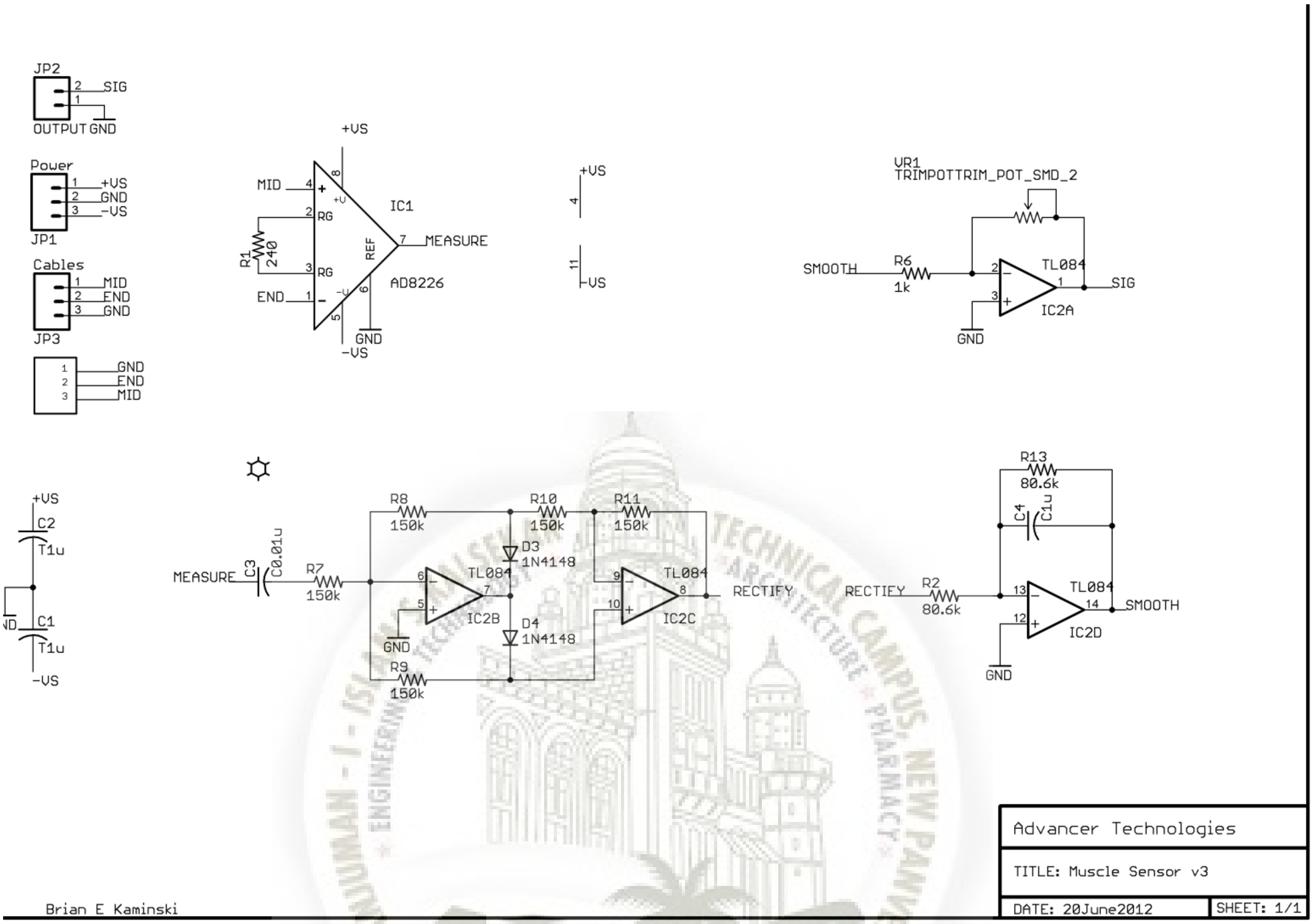
Our Muscle Sensors are designed to be used directly with a microcontroller. Therefore, our sensors do not output a RAW EMG signal but rather an amplified, rectified, and smoothed signal that will work well with a microcontroller's analog-to-digital converter (ADC). This difference can be illustrated by using a simple sine wave as an example.



Raw sine wave



full wave rectifier


JP2
SIG
OUTPUT GND
Power
+VS
GND
-VS
JP1
Cables
MID
END
GND
JP3
GND
END
MID
+VS
MID
END
R1
240
IC1
AD8226
MEASURE
GND
-VS
+VS
-VS
VR1
TRIMPOTTRIM_POT_SMD_2
SMOOTH
R6
1k
TL084
SIG
IC2A
GND
+VS
C2
T1u
C1
T1u
-VS
MEASURE
C3
C0.01u
R7
150k
R8
150k
TL084
IC2B
GND
D3
1N4148
D4
1N4148
R9
150k
R10
150k
R11
150k
TL084
IC2C
RECTIFY
R13
80.6k
C4
C1u
RECTIFY
R2
80.6k
TL084
SMOOTH
IC2D
GND
Advancer Technologies
TITLE: Muscle Sensor v3
DATE: 20June2012
SHEET: 1/1
Brian E Kaminski

CODING

```
void setup() {
  // put your setup code here, to run once:
pinMode(11, OUTPUT);
pinMode(10, OUTPUT);
pinMode(A5, INPUT);
Serial.begin(9600);

}

void loop() {

  const int redPin=analogRead(A5);
  int pre=analogRead(redPin);
 Serial.print("\nsensorValue");
/////////////////////////Serial.print(analogRead(redPin));
//Serial.print(pre);
Serial.print(analogRead(redPin));

delay(100);
int cur=analogRead(redPin);
if(cur==pre)
{
  digitalWrite(10, LOW);
  digitalWrite(11, LOW);
  }
if(cur>pre)
{
  digitalWrite(10, HIGH);
  digitalWrite(11, LOW);
  delay(100);
}

//delay(4000);
if(cur<pre)
{
digitalWrite(10, LOW);
 digitalWrite(11, HIGH);
 delay(100);
}
//delay(4000);


}
```

RAW MATERIAL

SR NO	PART NAME	MAT	QTY
1	FRAME	MS	4 KG
2	GEARED MOTOR	PMDC	1
3	NITRILE RUBBER	NITRILE	5 M
4	BATTERY 12V	LEAD ACID	1
5	POP RIVIT	STD	20
6	CONNECTOR	STD	4
7	WIRE	CU	1 M
8	CLIP	STD	2
9	PAINTING	STD	1
10	ELIMETER	STD	1
11	MISSILINO US		-

COST ESTIMATION

Cost estimation may be defined as the process of forecasting the expenses that must be incurred to manufacture a product. These expenses take into a consideration all expenditure involved in a design and manufacturing with all related services facilities such as pattern making, tool, making as well as a portion of the general administrative and selling costs.

PURPOSE OF COST ESTIMATING:

1. To determine the selling price of a product for a quotation or contract so as to ensure a reasonable profit to the company.
2. Check the quotation supplied by vendors.
3. Determine the most economical process or material to manufacture the product.
4. To determine standards of production performance that may be used to control the cost.

<u>BASICALLY THE BUDGET ESTIMATION IS OF TWO TYRES:</u>

1. material cost
2. Machining cost

MATERIAL COST ESTIMATION:

Material cost estimation gives the total amount required to collect the raw material which has to be processed or fabricated to desired size and functioning of the components.

These materials are divided into two categories.

1. Material for fabrication:

In this the material in obtained in raw condition and is manufactured or processed to finished size for proper functioning of the component.

1. Standard purchased parts:

This includes the parts which was readily available in the market like allen screws etc. A list is forecast by the estimation stating the quality, size and standard parts, the weigh of raw material and cost per kg. For the fabricated parts.

MACHINING COST ESTIMATION:

This cost estimation is an attempt to forecast the total expenses that may include to manufacture apart from material cost. Cost estimation of manufactured parts can be considered as judgment on and after careful consideration which includes labour, material and factory services required to produce the required part.

-

SR. NO.	OPERATION	HOURS	RATE / LABOUR	AMOUNT
1.	Turning	10	150	2000
3.	Drilling	7	100	900
4.	Welding	16	175	2800
5.	Grinding	3	60	200
6.	Tapping	3	40	150
7.	Cutting	8	40	350
8.	Gas cutting	8	50	400
9.	Assembly	2	100	200
10.	Painting	2	100	200
			TOTAL	7200

Sr. No.	Particulars	Cost
1	Number of Specimens:	
1.1	➢ Electric linear actuator	3000
1.2	➢ Aluminium frame	5000
1.3	➢ battery	1200
1.4	➢ Arduino and EMG muscle sensor	4000
1.5	Breadboard and wires	500
1.6	➢ Battery 9v x10	500
1.7	➢ insulation	1000
2	ASTHETICS	1000
3	MC WORK	2500
4	INDIRECT COST	
4.1	transportation	1000
4.2	drawing	800
4.3	refreshment	1000
4.4	Project report	3000
5	MISCELLANEOUS	1000
	Total	**Rs /-25500**

TOTAL COST

Raw Material Cost + STD Parts Cost + Direct Labour Cost +Indirect Cost

Total cost of project = 7200+25500

Total cost of project = 32700/-

3.4 TIME ACTIVITY CHART

Work	July 17	Aug 17	Sept 17	Oct 17	Nov 17	Dec 17	Jan 18	Feb 18	March 18	April 18	May 18
Literature survey											
Problem definition											
Objectives											
Process parameter selection											
Experimentation • Test runs											
• Actual machining											
Measurement of responses											
Processing											
Demonstration											
Confirmation test (results)											
Conclusion											

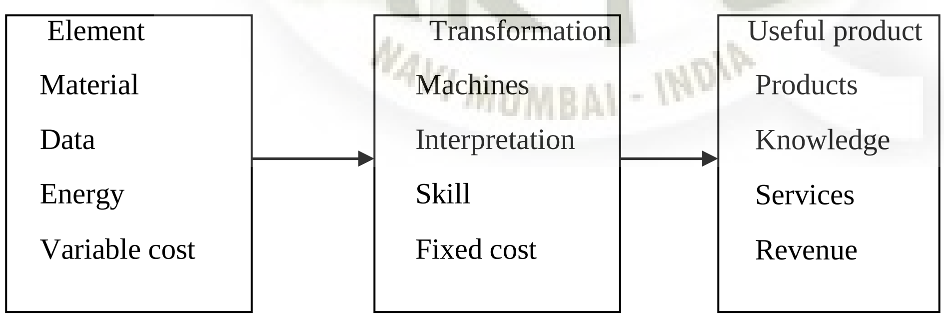
Work completed	
Work remained	

CHAPTER NO

MANUFACTURING

The process of conversion of raw material in to finished products using the three resources as Man, machine and finished sub-components.

Manufacturing is the term by which we transform resource inputs to create Useful goods and services as outputs. Manufacturing can also be said as an intentional act of producing something useful . The transformation process is Shown below-



It s the phase after the design. Hence referring to the those values we will plan The various processes using the following machines:-

i) Universal lathe

ii) Milling machine

iii) Grinding machine

iv) Power saw

v) Drill machine

vi) Electric arc welding machine

COMPONENT: FRAME

MATERIAL:- M.S. ANGLE

QUANTITY : - 1

SR. NO	DESCRIPTION OF OPERATION	MACHINE USED	CUTTING	MEASUREMENT
1	Cutting the angle in to length as per dwg	Gas cutting machine	Gas cutter	Steel rule
2	Cutting the angle in to number of piece as per dwg	Gas cutting machine	Gas cutter	Steel rule
3	Filing operation can be performed on cutting side and bring it in perpendicular C.S.	Bench vice	File	Try square
4	Weld the angles to the required size as per the drawing	Electric arc welding machine	-------	Try square
5	Drilling the frame at required points as per the drawing.	Radial drill machine	Twist drill	Vernier calliper

NAME OF THE PART – SHAFT

MATERIAL – BRIGHT STEEL

QUANTITY – 2

SR.NO.	DETAIL OPER.	M/C. USED	TOOL USED	ACCES	MEA.INST.
1.	Marking on shaft	-	-	-	Scale
2.	Cutting as per dwg	Power hack saw	Hock saw blade	Jig & fixtures	Scale
3.	Facing both side of shaft	Lathe machine	Single point cutting tool	Chuck	Vernier caliper
4.	Turning as per dwg size	-	-	-	-
5.	Key way on end of shaft	Milling m/c.	Milling cutter	-	Vernier caliper
6.	Filling on both end	Flat file		Vice	-

COMPONENT: PULLEY

MATERIAL:- C.I

QUANTITY : - 2

SR. NO	DESCRIPTION OF OPERATION	MACHINE USED	CUTTING	MEASUREMENT	TIME
1	Take standard pulley as per design	------	----------	-------------	---------
2	Face both side of hub portion	Lathe machine	Single point cutting tool	Vernier caliper	15 min.
3	Hold it in three jaw chuck & bore inner dia as per shaft size	Lathe machine	Single point cutting tool	Vernier caliper	20 min.
4	Drilling the hub at required points as per the drawing	Radial drill machine	Twist drill	Vernier calliper	10 min.
5	Tap the hub at drill area.	Hand tap set	Tap	Vernier calliper	10 min.

NAME OF THE PART – SLIDE BUSH

MATERIAL – M.S

QUANTITY – 2

SR.NO.	DETAIL OPER.	M/C. USED	TOOL USED	ACCES	MEA.INST.
1.	Marking on pipe	-	-	-	Scale
2.	Cutting as per dwg	Power hack saw	Hock saw blade	Jig & fixtures	Scale
3.	Facing both side of pipe	Lathe machine	S.P.C.T	Chuck	Vernier caliper
4.	Turning as per dwg size	-	-	-	-
5	Filling on both end	Flat file		Vice	
6	Drill number of holes on pipe	Drilling m/c	Drill bit	Clamp	Vernier caliper

MAINTENANCE

No machine in the universe is 100% maintenance free machine. Due to its continuous use it is undergoing wear and tear of the mating and sliding components. Also due to the chemical reaction takes place when the material comes in the contact with water, makes its corrosion and corrosion. Hence it is required to replace or repair. This process of repairing and replacing is called as maintenance work.

AUTONOMOUS MAINTAINENCE ACTIVITY:-

1) Conduct initial cleaning & inspection.
2) Eliminate sources of dirt debris excess lubricants.
3) Improve cleaning maintainability.
4) Understand equipment functioning.
5) Develop inspection skills.
6) Develop standard checklists
7) Institute autonomous inspection
8) Organize and manage the work environment
9) Manage equipment reliability.

CLAIR → CLEANING , LUBRICATING , ADJUSTMENT, INSPECTION

CLEANING

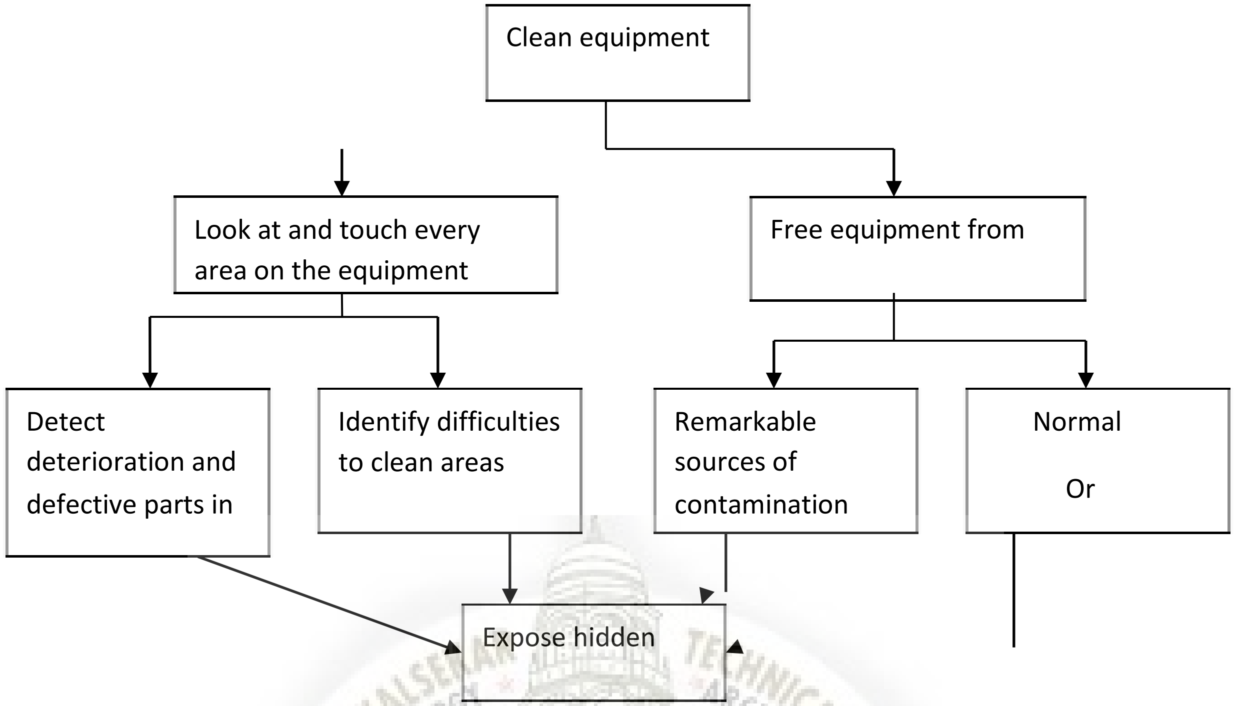
Why cleaning ?

Prevent or eliminate contamination.

Find ways to simplify the cleaning process.

Facilitates through inspection when done by knowledgeable operators and \ or maintainers.

CLEANING IS INSPECTION….



CLEANING PROCESS

- What to look for when cleaning.
    - Missing part
    - Wear
    - Rust and corrosion
    - Noise
    - Cracks
    - Proper alignment
    - Leaks
    - Play or sloppiness

VISUAL AIDS TO MAINTAIN CORRECT EQUIPMENT CONDITION

- Match marks on nut and bolts
- Color marking of permissible operating ranges on dials and gauges
- Marking of fluid type and flow direction of pipes

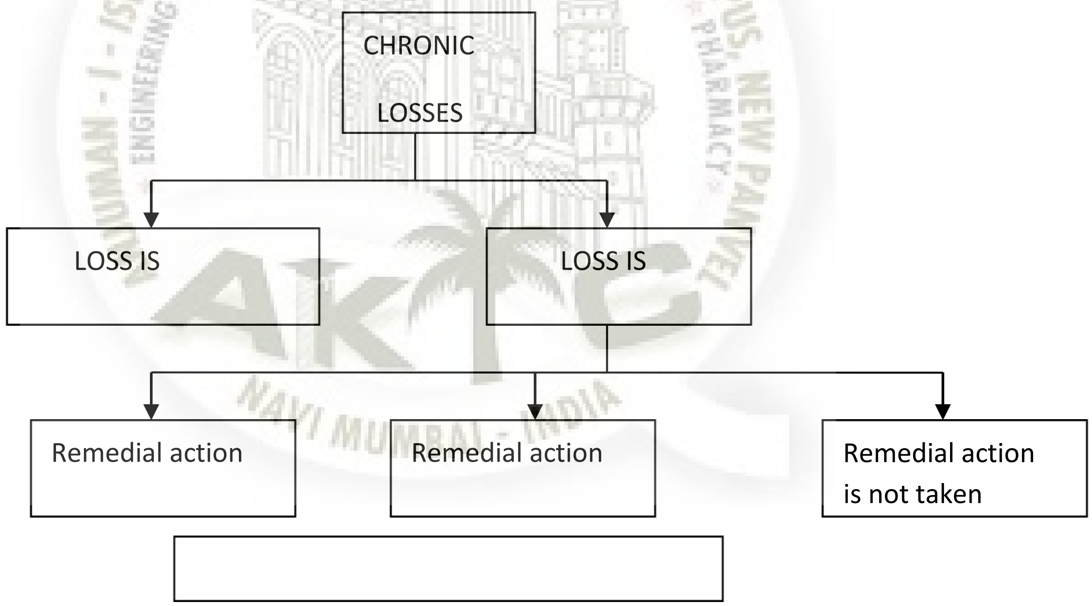
- Marking at open / closed position on valves
- Labeling at lubrication inlets and tube type
- Marking minimum / maximum fluid levels
- Label inspection sequences

ADJUST & MINOR REPAIR

Minor repairs if

- Trained
- Experienced
- Performs safety
- Simple tool required
- Not longer than 20/30 minutes

CHRONIC DEFECTS



EQUIPMENT IMPROVEMENT

1. Restore obvious deterioration throughout.
2. Establish plan select pilot area , determine bottleneck.
3. Study and understand the production process.
4. Establish goals for improvement.

5. Clarify the problem, collect the reference manuals contact resources.
6. Conduct evaluation through such techniques as RCM analysis, FMECA, FTA (Root cause failure analysis).
7. Determine improvement priorities, costs and benefits.
8. Execute improvement in pilot area standardize technique and document what you have done.
9. Monitor results and optimize based on those results.
10. Implement plant wide

<u>EQUIPMENT RESPONSIBILITIES OF OPERATOR</u>

Operation with the proper standard procedure.

Failure prevention.

Failure resolution.

Inspection.

Equipment up keep.

Cleaning.

Lubricating.

Lightning fasteners.

Minor repairs.

Trouble shooting.

CONCLUSION AND FUTURE OUTCOME

1. Surviving a stroke or debilitating injury is often the start of a very long ordeal. Physical therapy can be slow and strenuous with no guarantee of recovery. Robotic exoskeletons can sometimes provide the support a ravaged body needs to heal and strength when it can't.

2. The integration of human and robot into a single system offers remarkable opportunities for a
3. new generation of assistive technology.

4. Military: There are an increasing amount of applications for an exoskeleton, such as decreased fatigue and increased productivity whilst unloading supplies or enabling a soldierto carry heavy objects (80–300 kg) while running or climbing stairs. Not only could a soldier potentially carry more weight, presumably, they could wield heavier armor and weapons while lowering their metabolic rate or maintaining the same rate with more carry capacity. Some models use a hydraulic system controlled by an on-board computer. They could be powered by an internal combustion engine, batteries, or potentially fuel cells.
5. Civilian: In civilian areas, exoskeletons could be used to help firefighters and other rescue workers survive dangerous environments
6. Can be further modified to be controlled by brain Using EEG
7. Can be similarly made for lower body, Neck, Shoulder

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