



Orthopaedics Hip Implant

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Hip is one of the largest's joints on human body.



It is a ball and socket joint.



The socket is formed by acetabulum, which is pelvis bone.

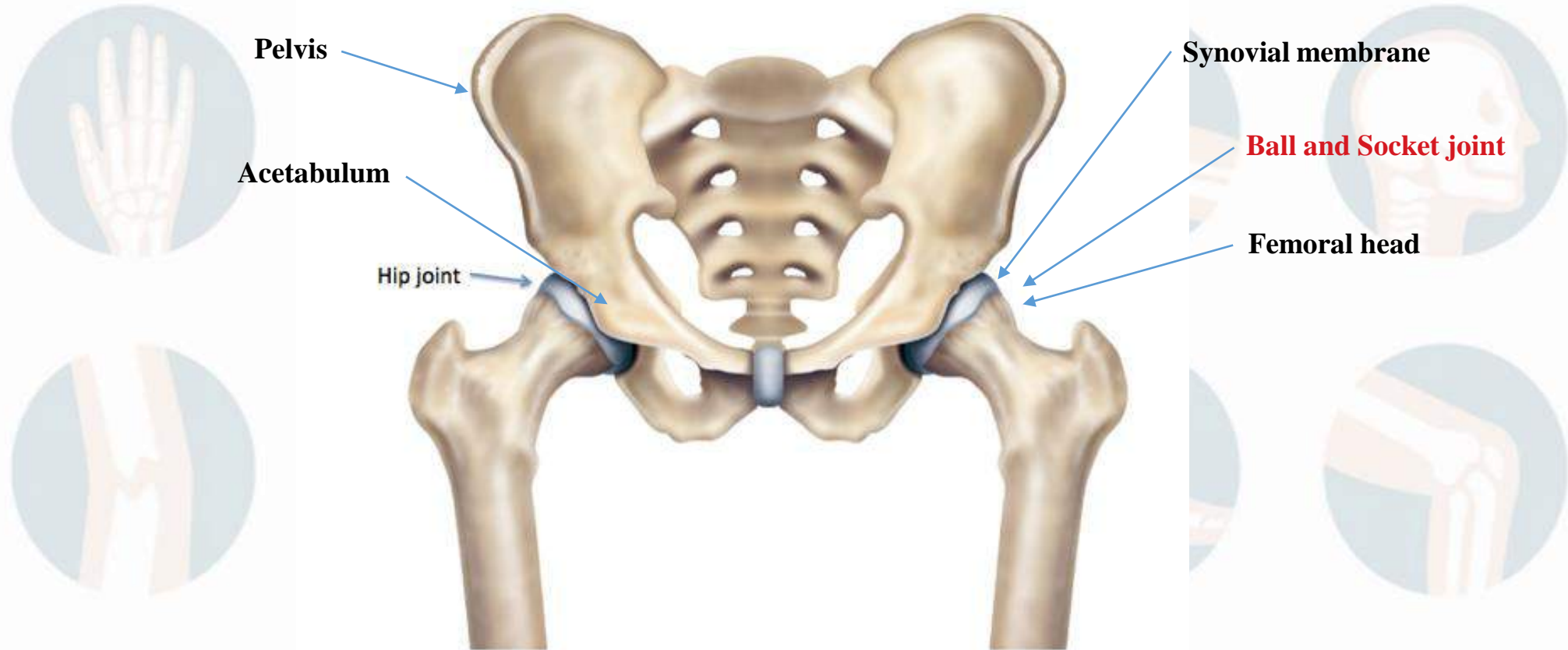


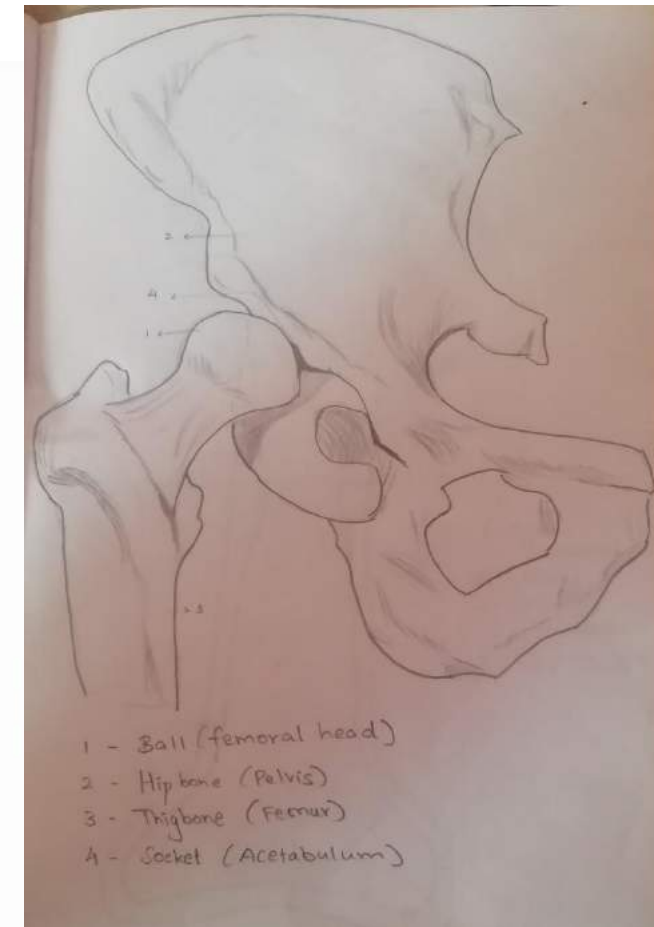
The ball is femoral head, which is the upper end of the femur.



A thin tissue called the synovial membrane surrounded the hip joint.







Cause of Replacement



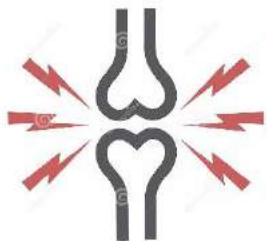
Osteoarthritis:

An age-related "wear and tear."



Rheumatoid arthritis:

The synovial membrane becomes inflamed and thickened.



Post-traumatic arthritis:

Hip injury or fracture.



Osteonecrosis:

Limit the blood supply to the femoral head.



Childhood hip disease:

Infants and children have hip problems.



Idea Generation



Idea 1:
Eliminating the defect one.



Idea 2:
Bringing the alternative material.



Idea 3:
Proposing consummate design.

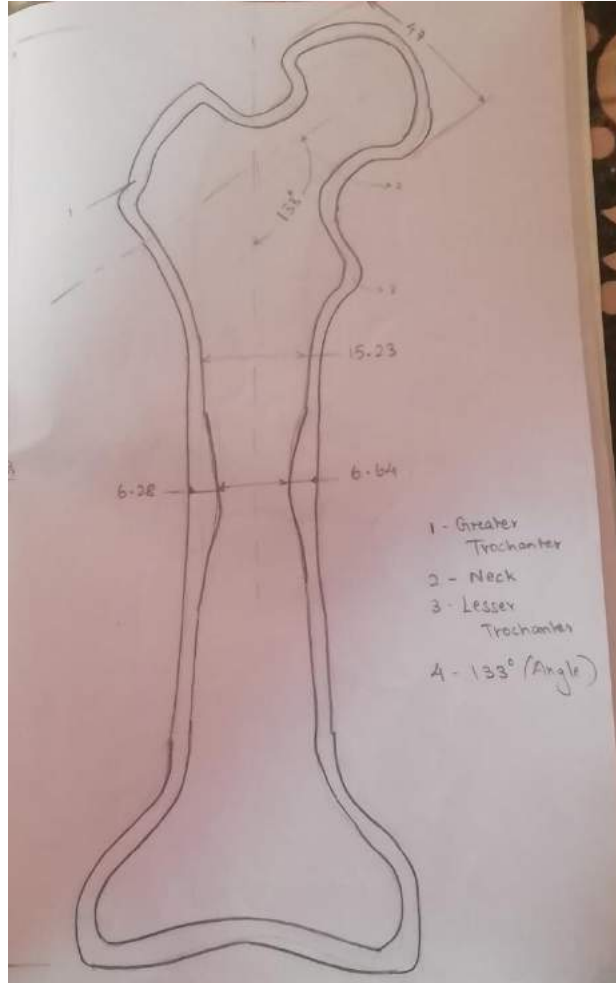


Idea 4:
Accomplish testing standards.



Idea Generation- Design

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Certain bone



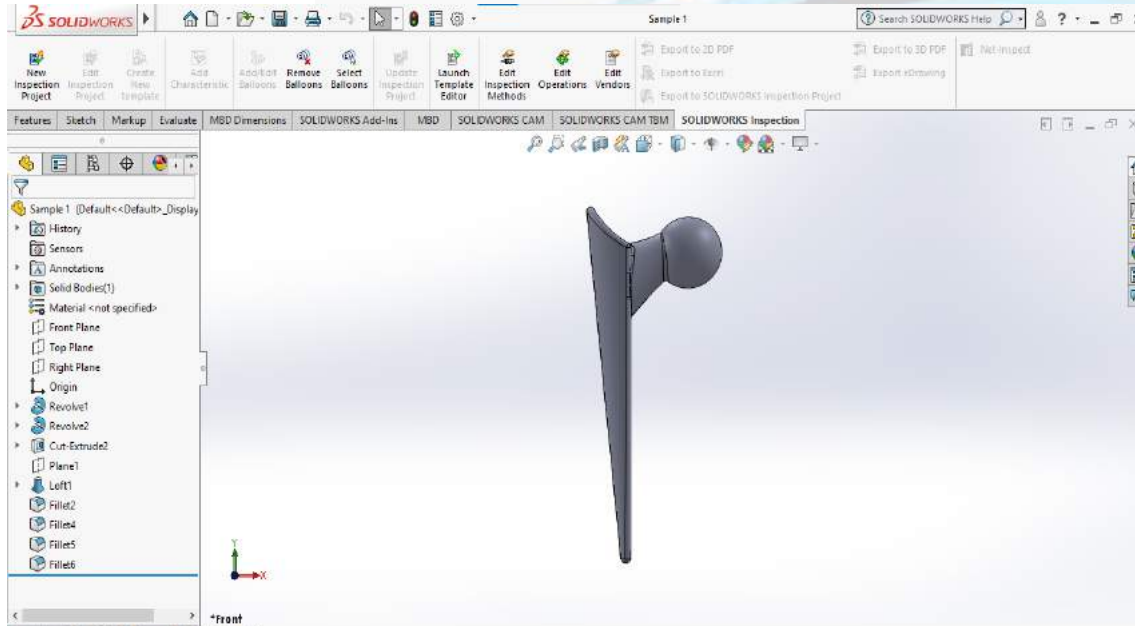
Predicted bone



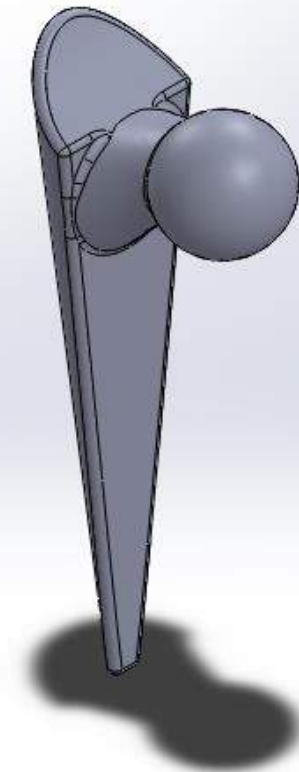
Orthopaedic Hip implant

Idea Generation- Design

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Sample 1



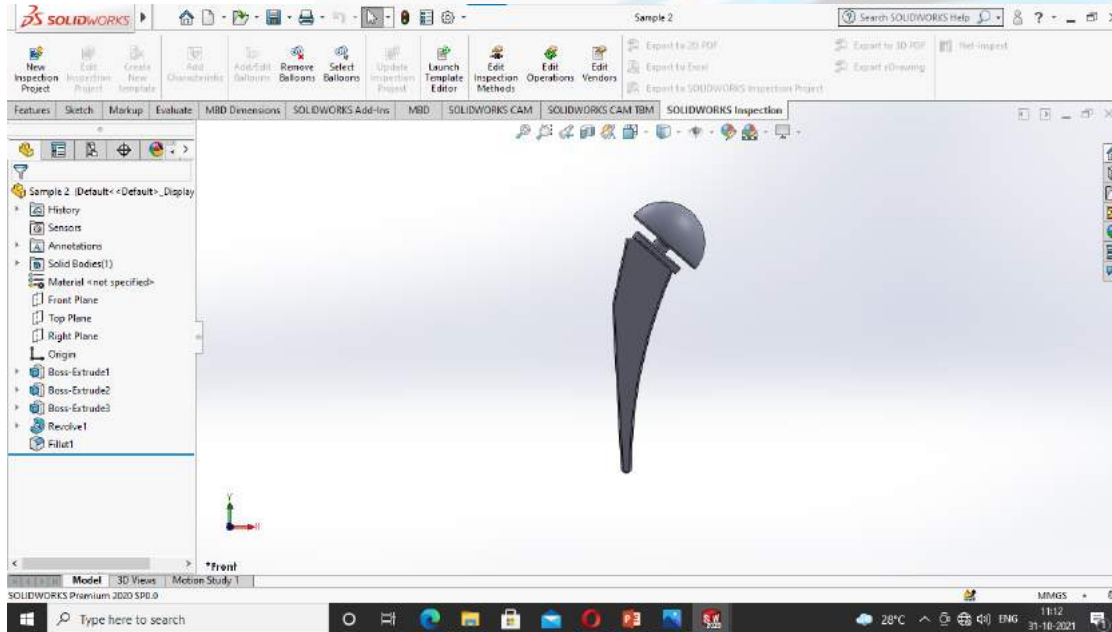
Isometric view



Orthopaedic Hip implant

Idea Generation- Design

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Sample 2



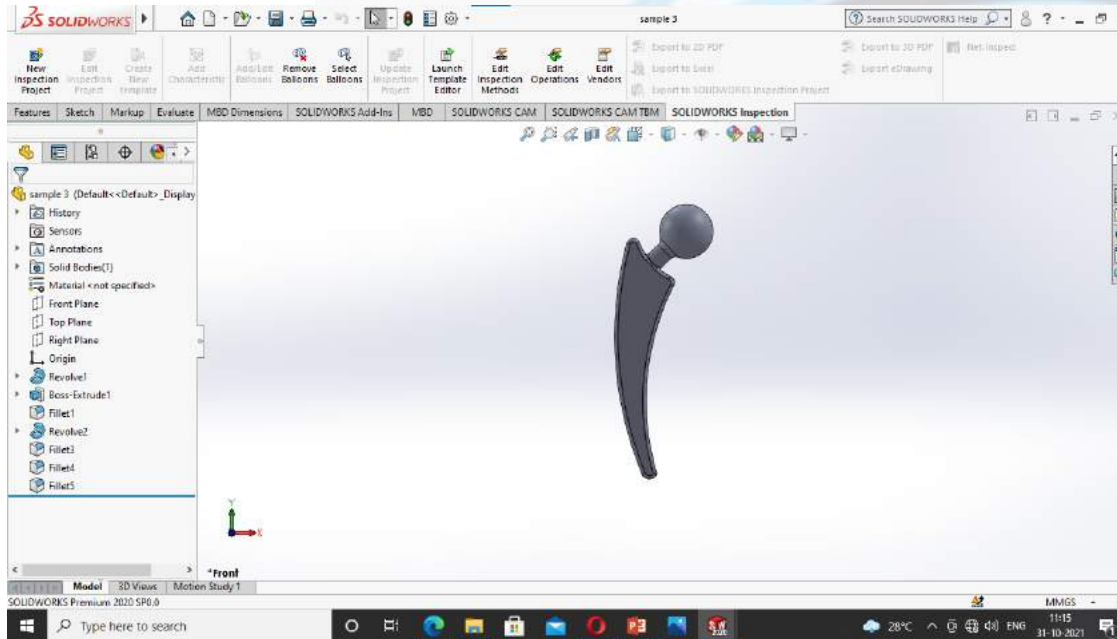
Isometric view



Orthopaedic Hip implant

Idea Generation- Design

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Sample 3



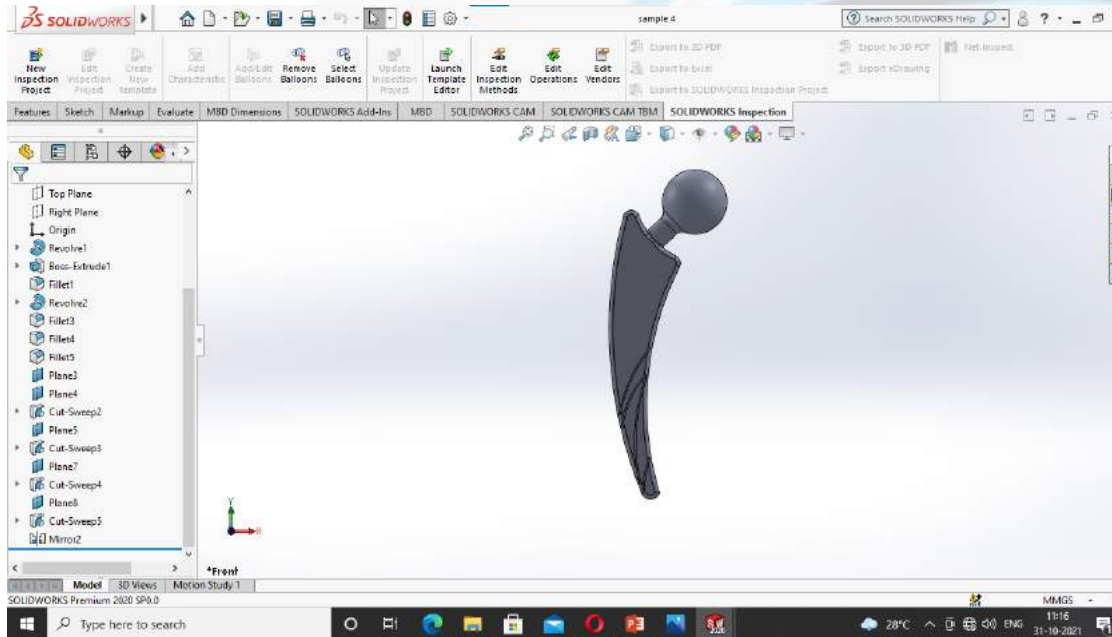
Isometric view



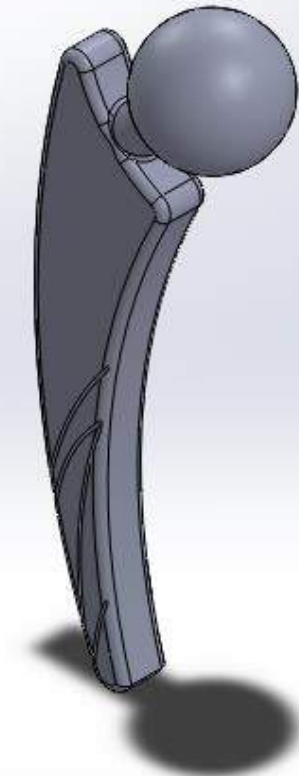
Orthopaedic Hip implant

Idea Generation- Design

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Sample 4



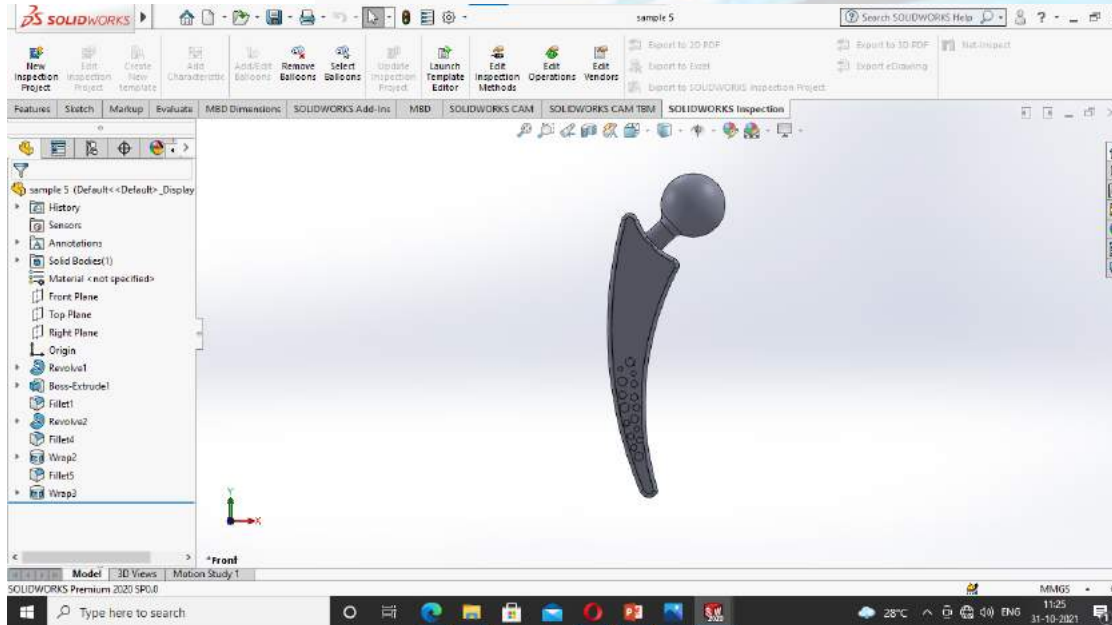
Isometric view



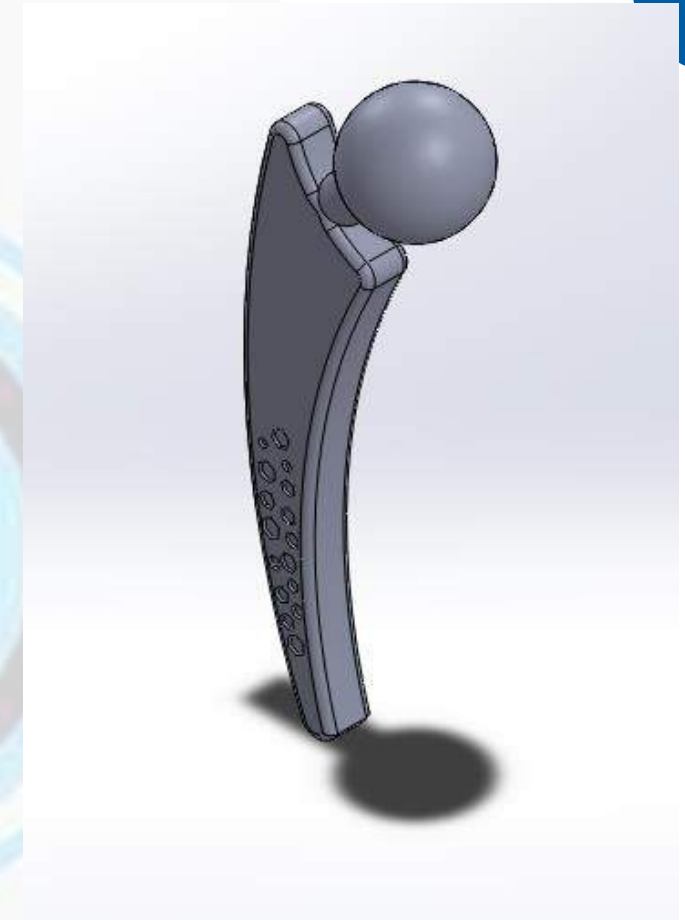
Orthopaedic Hip implant

Idea Generation- Design

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Sample 5



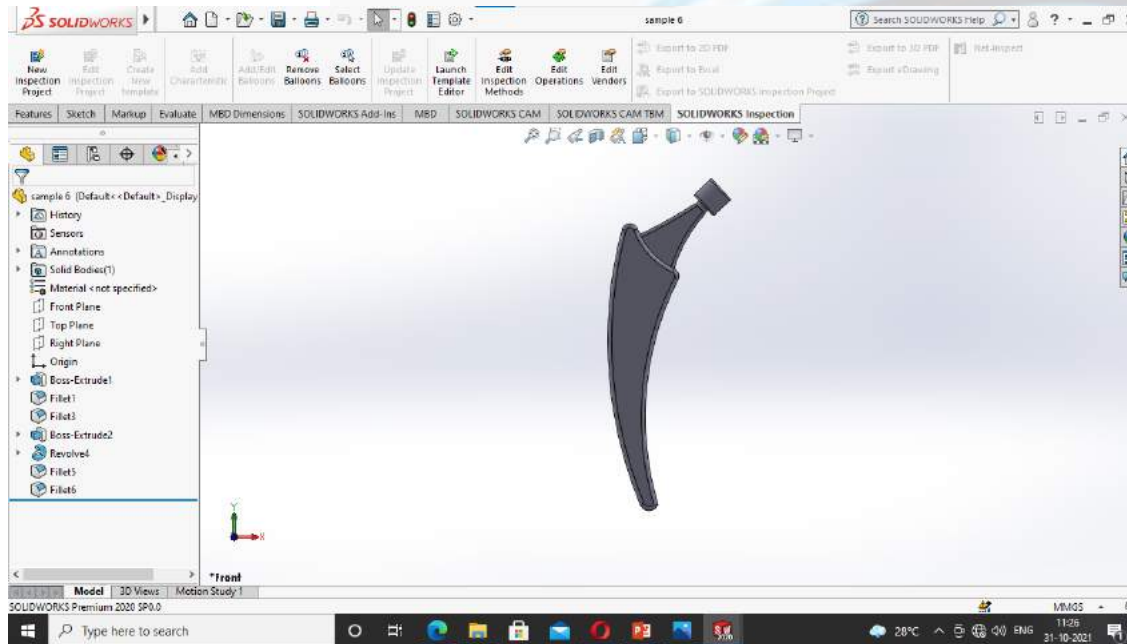
Isometric view



Orthopaedic Hip implant

Idea Generation- Design

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Sample 6

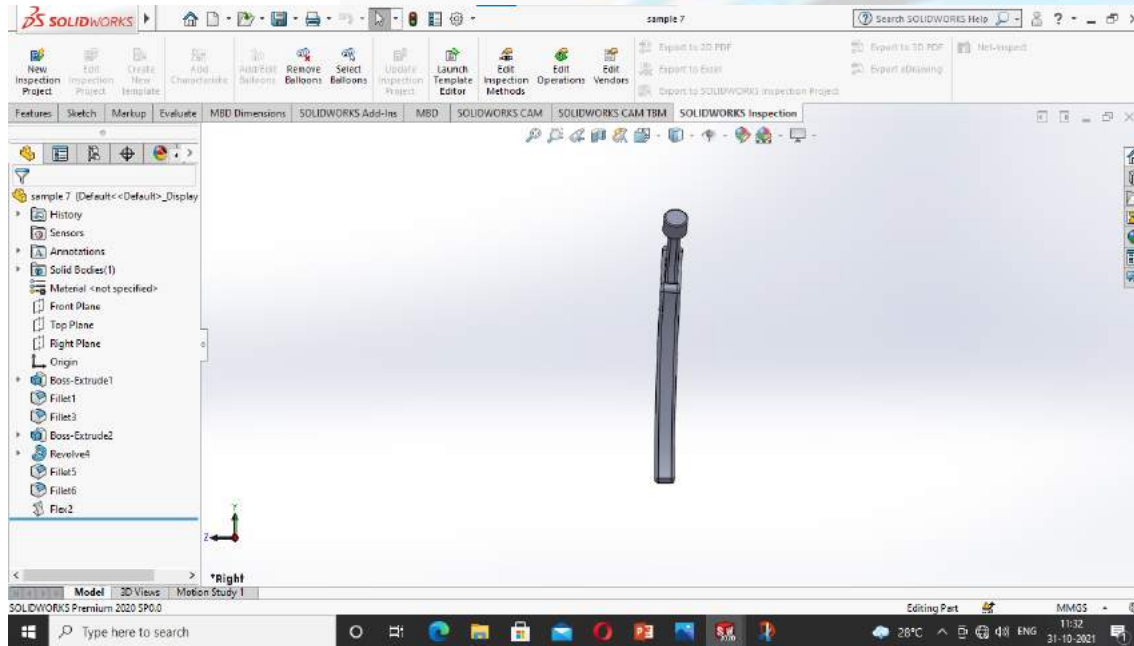


Isometric view

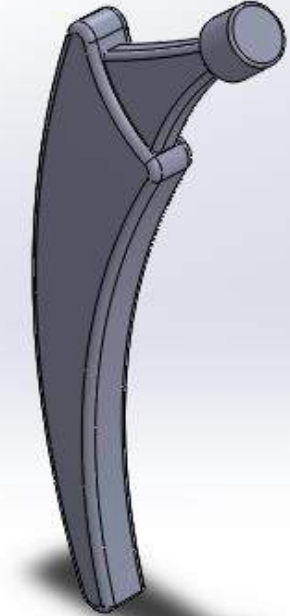


Orthopaedic Hip implant

Idea Generation- Design



Sample 7 (i.e. 5 degree bended)

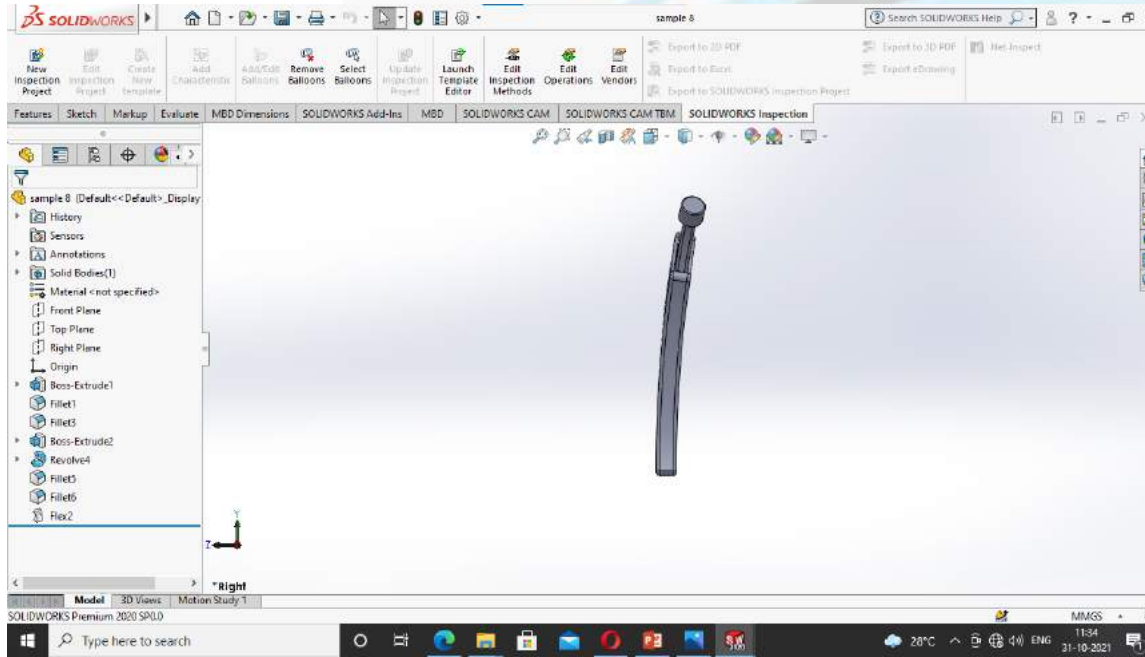


Isometric view

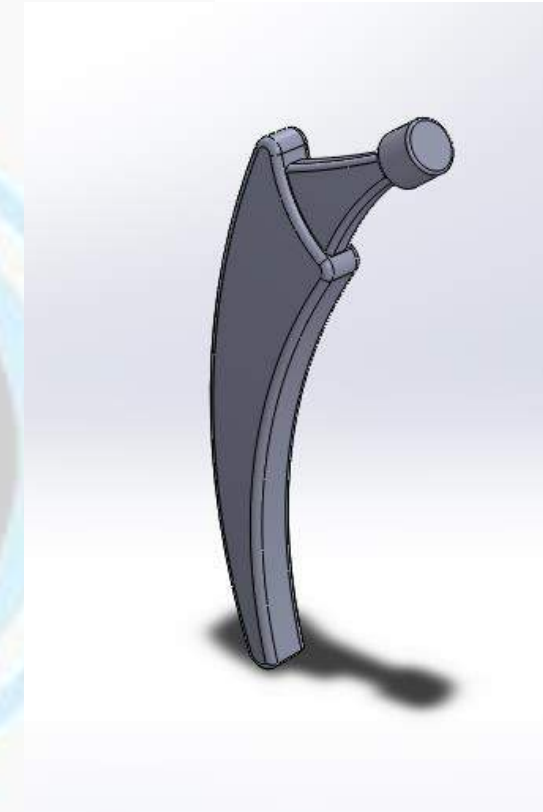


Orthopaedic Hip implant

Idea Generation- Design



Sample 8 (i.e. 12 degree bended)

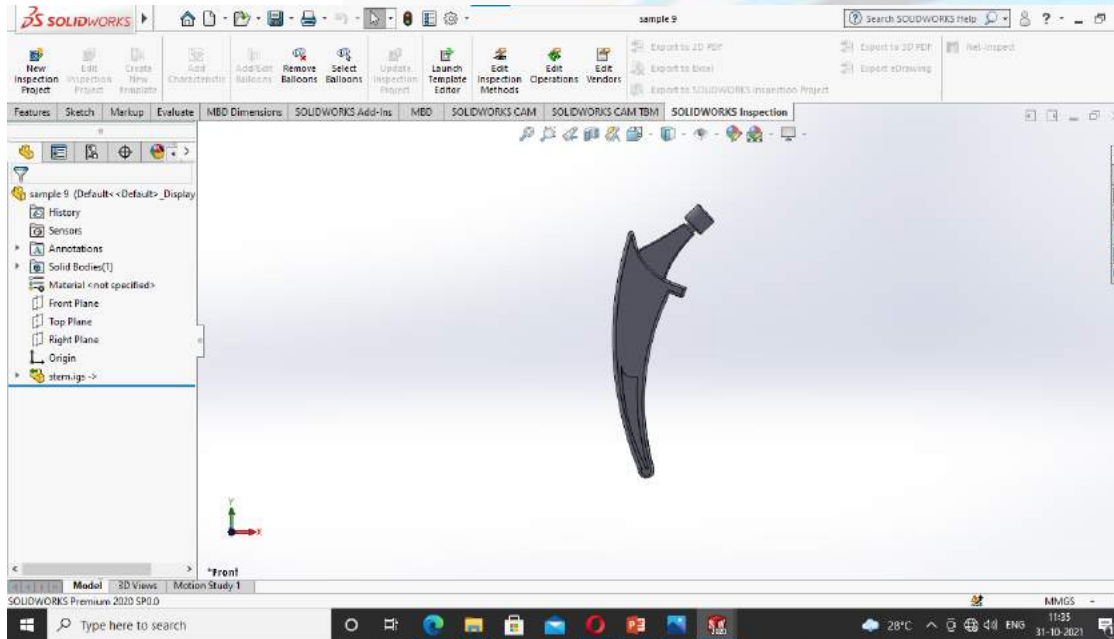


Isometric view



Orthopaedic Hip implant

Idea Generation- Design



Sample 9

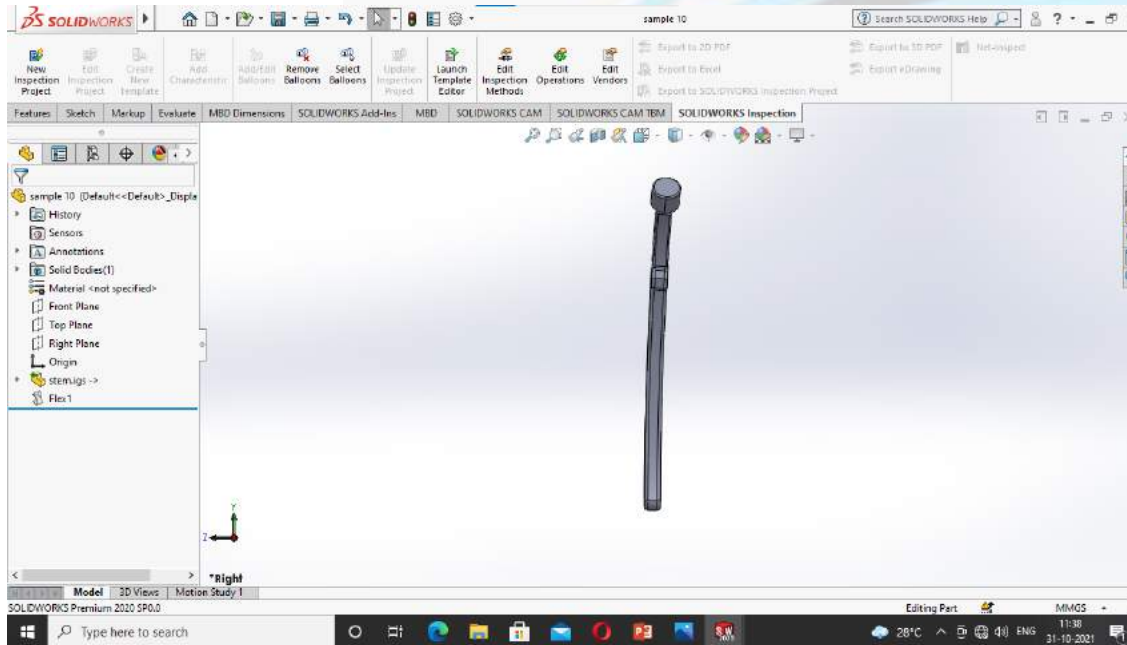


Isometric view



Orthopaedic Hip implant

Idea Generation- Design



Sample 10 (i.e. 5 degree bended)

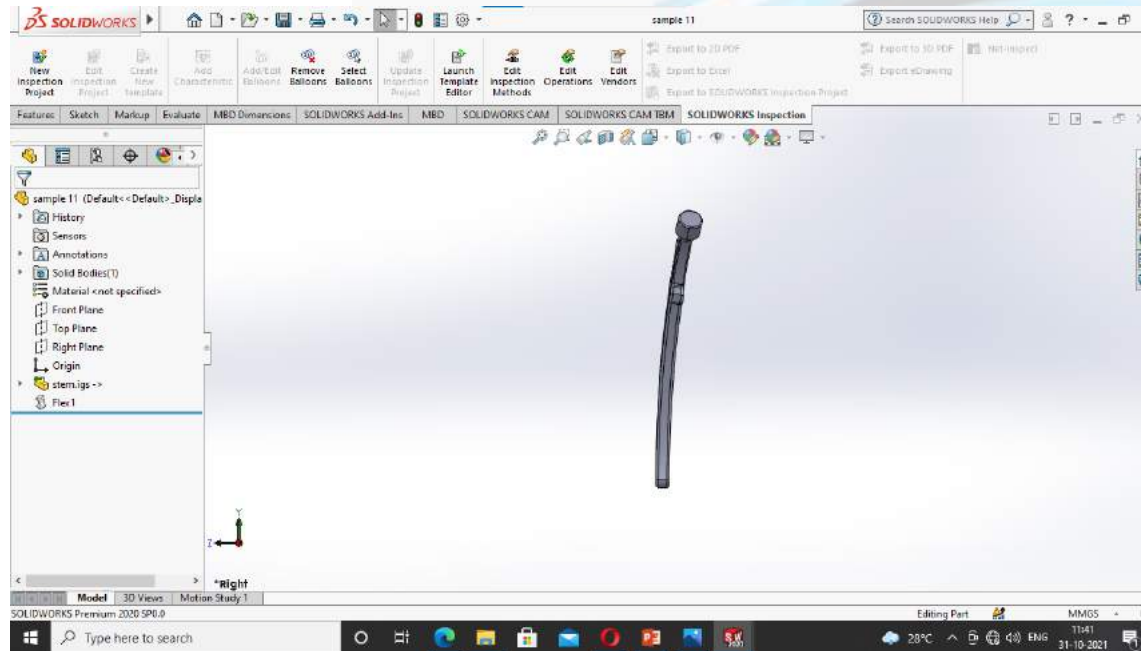


Isometric view



Orthopaedic Hip implant

Idea Generation- Design

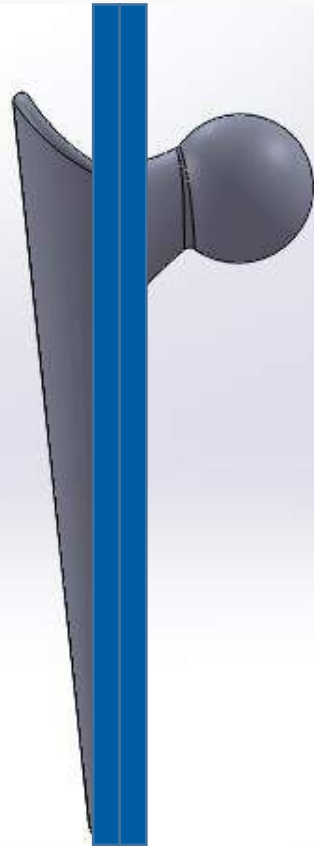


Sample 11 (i.e. 12 degree bended)

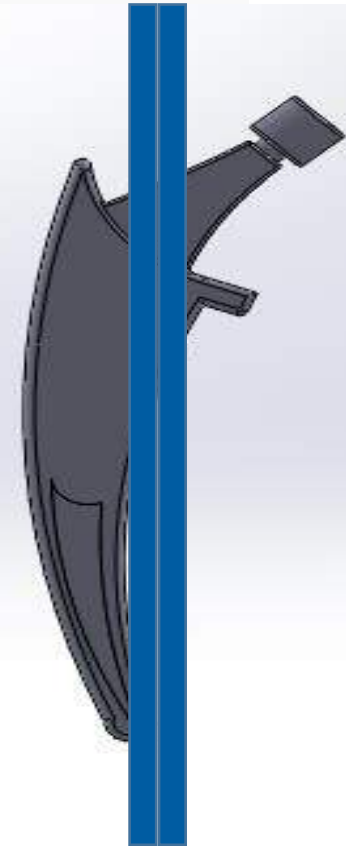


Isometric view





Scratch



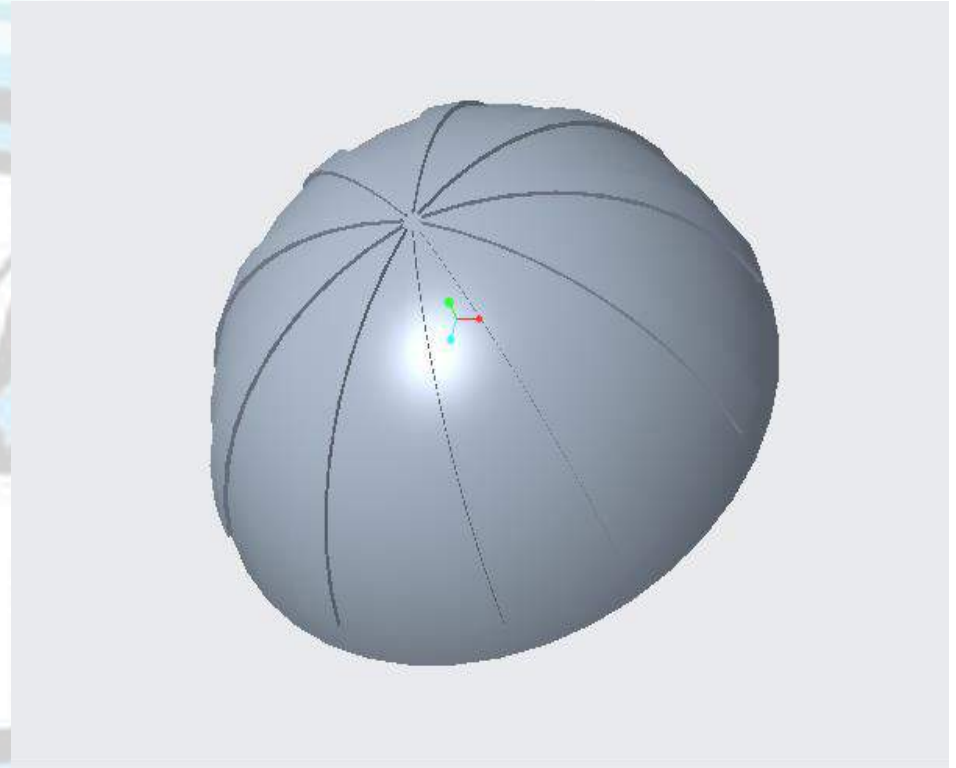
Consummate





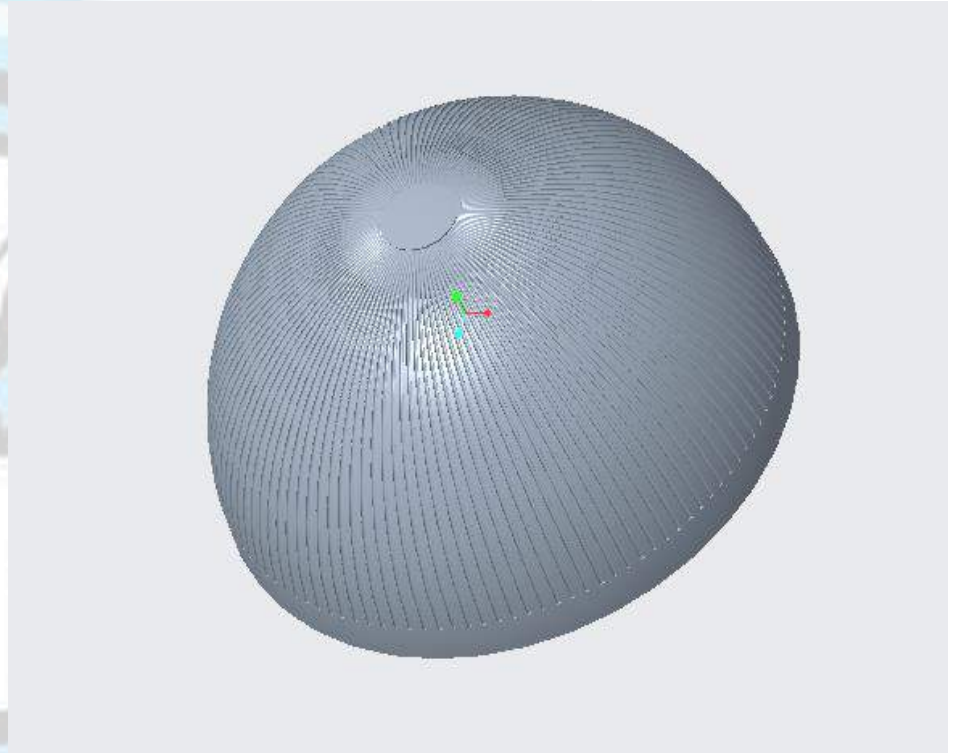
Ball design





Liner design



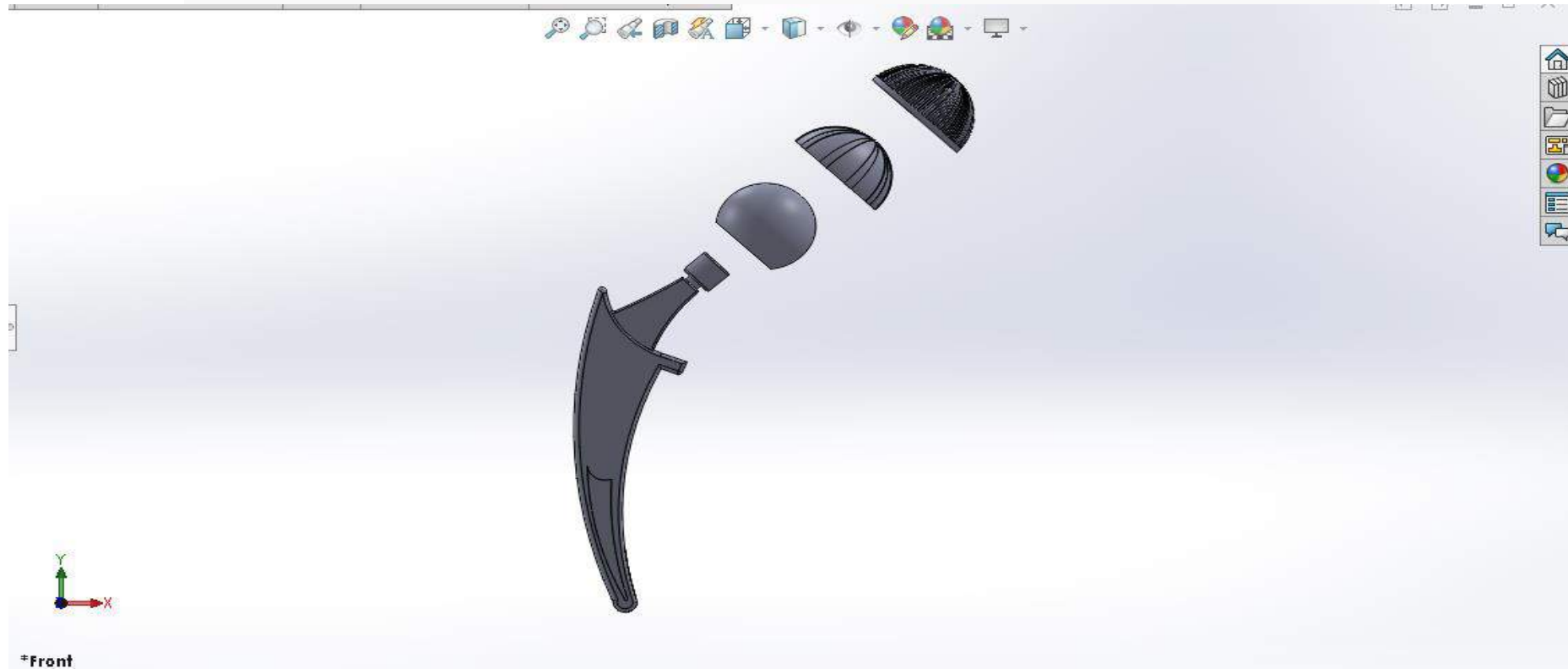


Cup design



Idea Screening- Design

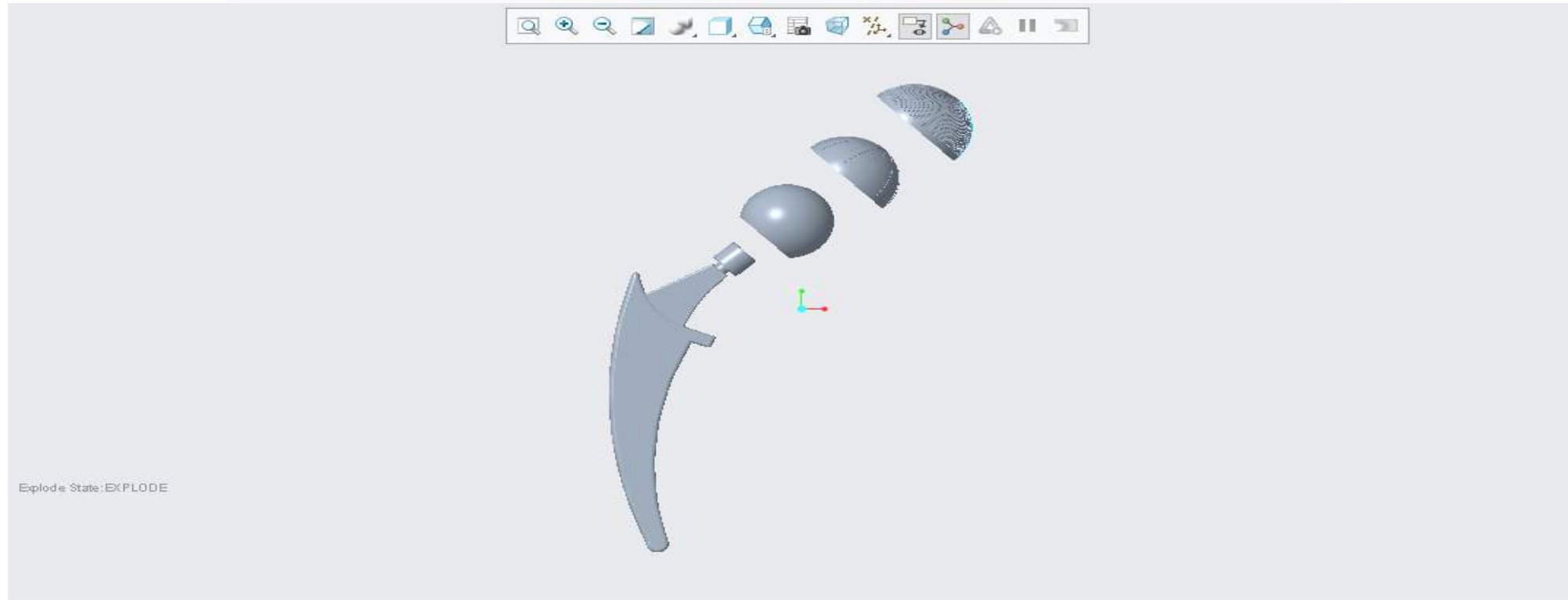
23



Assembly in Solid works

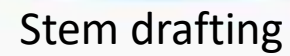


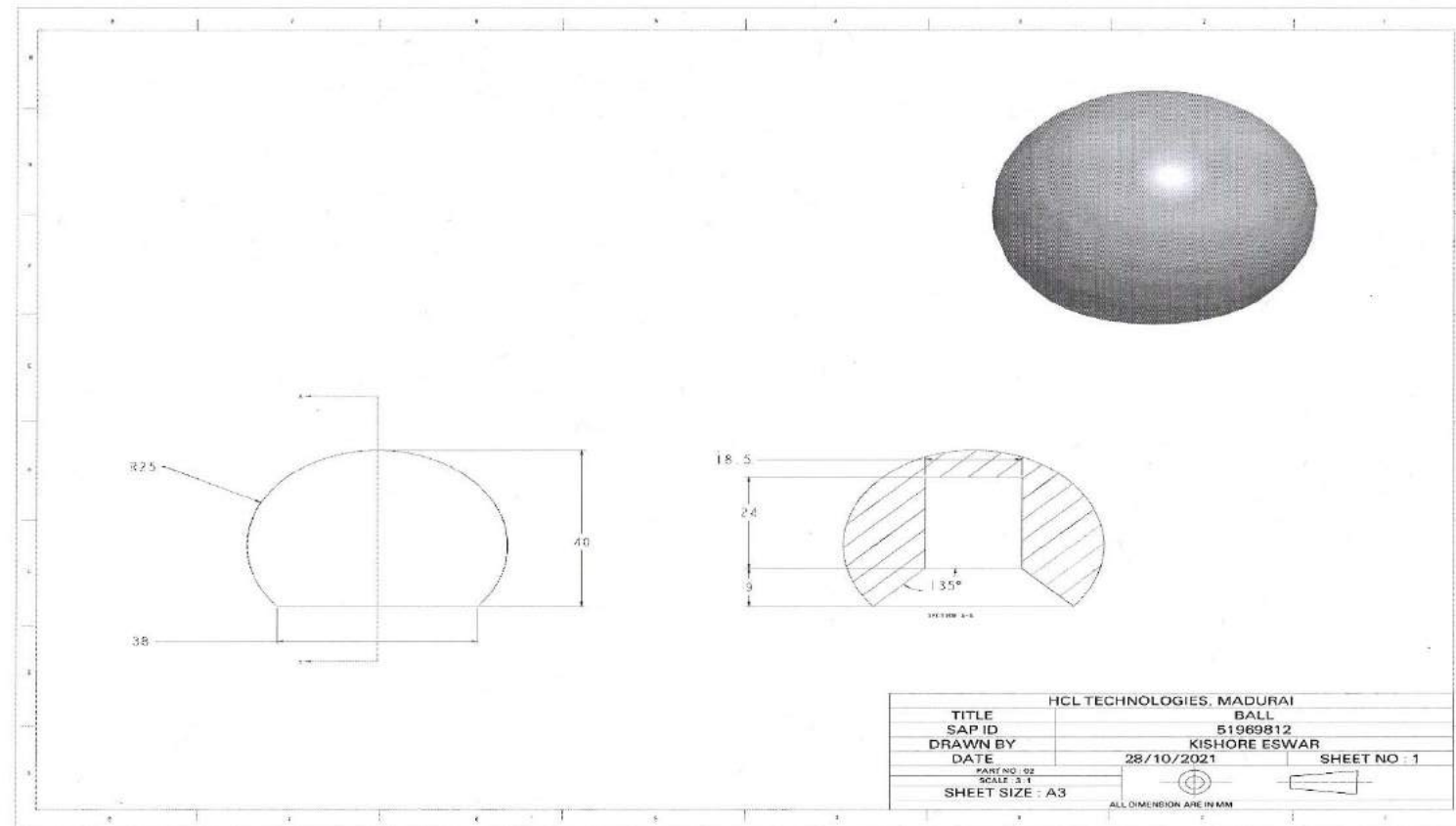
Orthopaedic Hip implant



Assembly in Creo

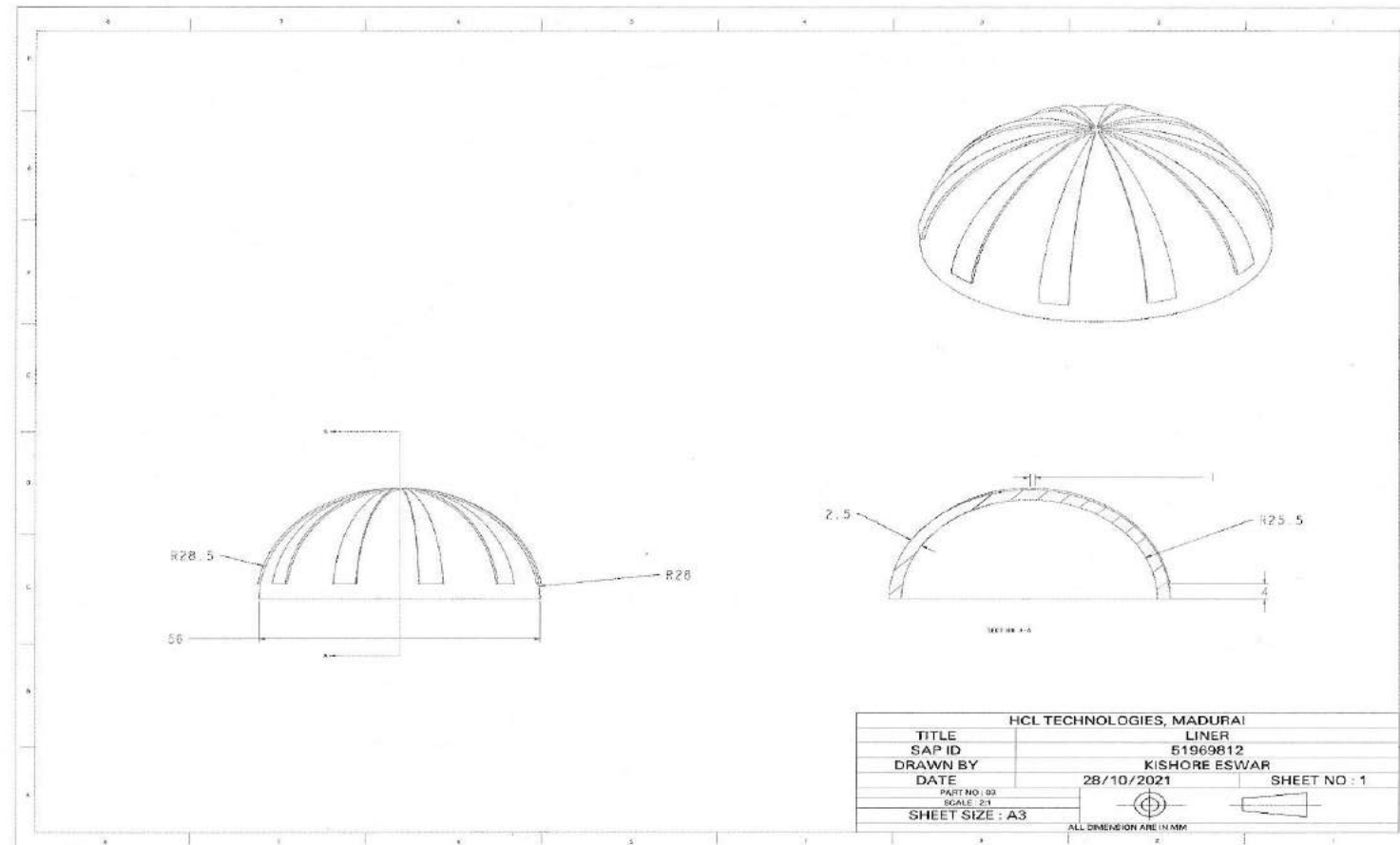






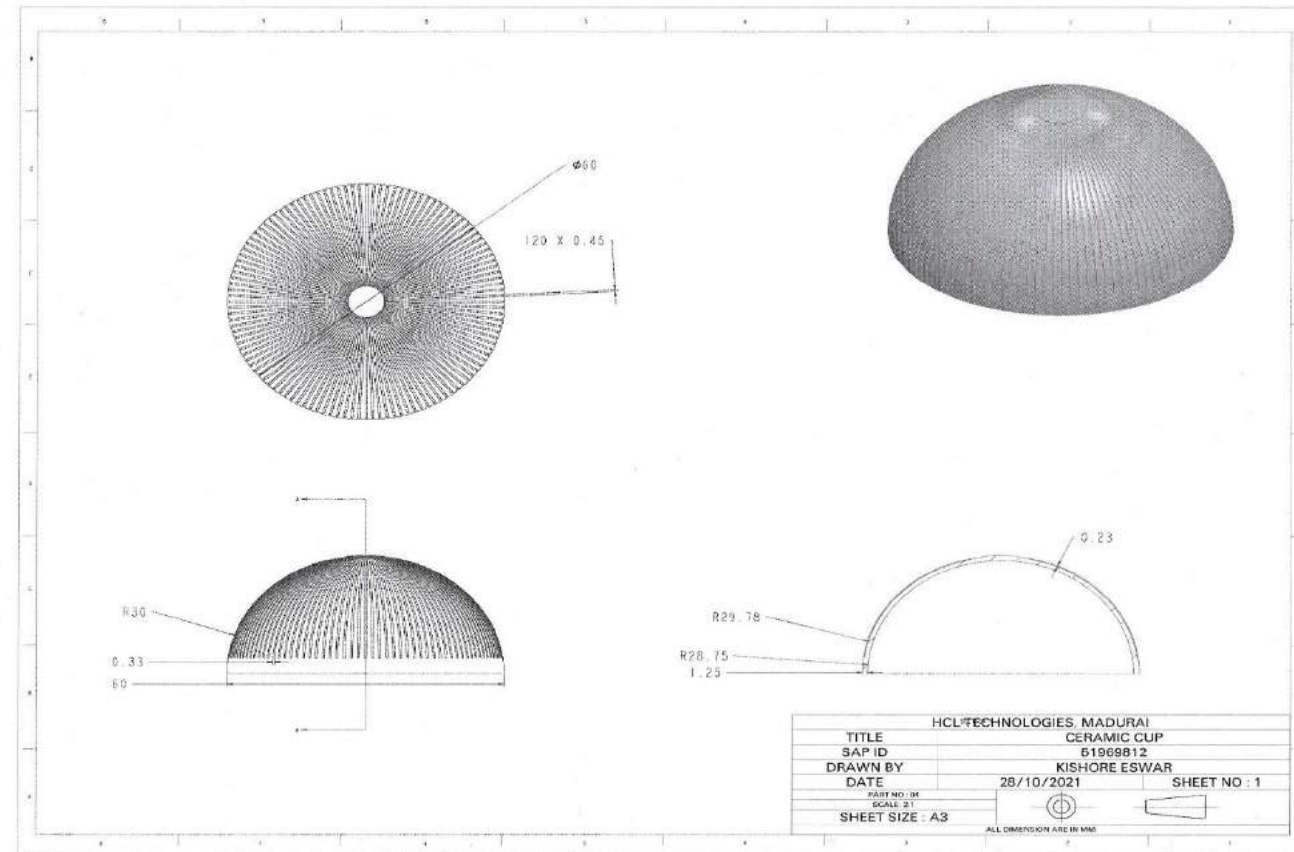
Ball drafting





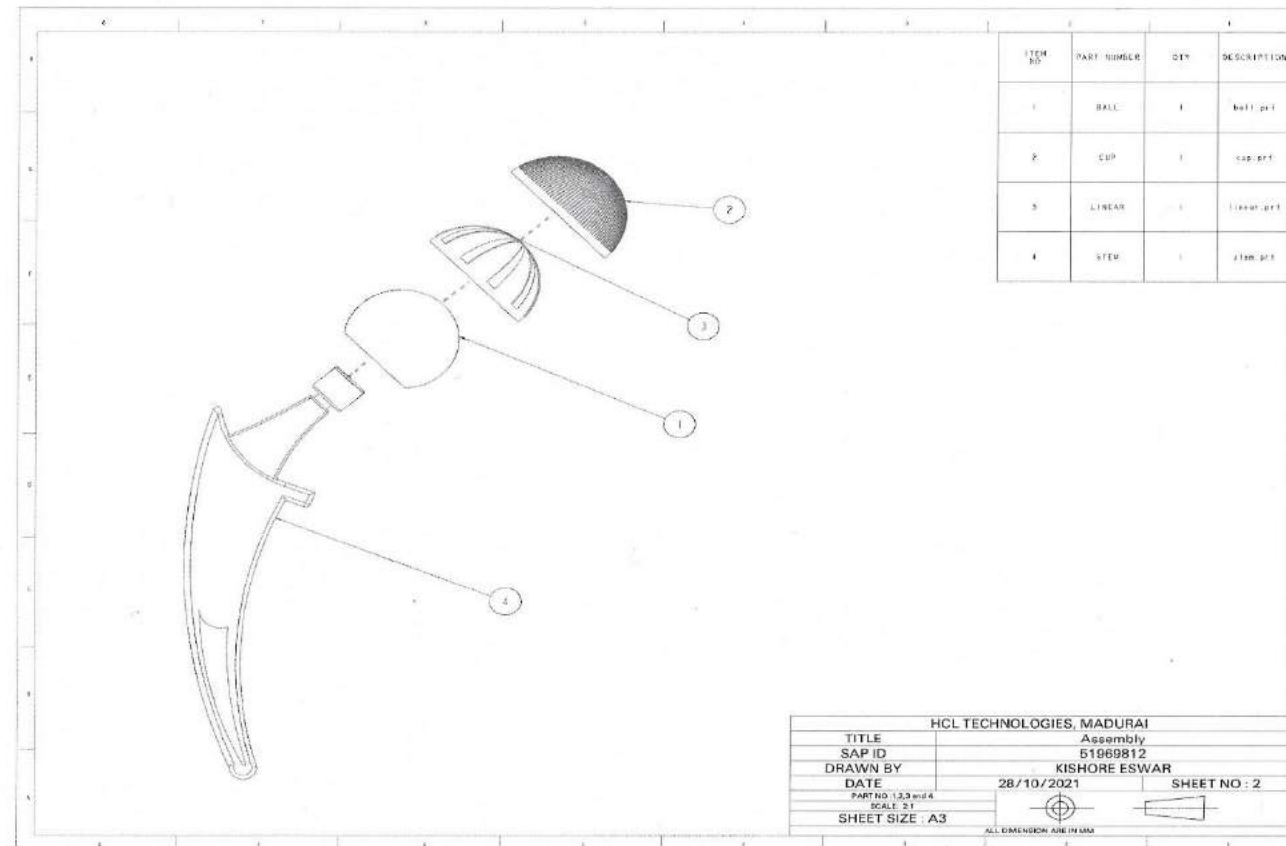
Liner drafting





Cup drafting





Assembly drafting



Idea Generation- Materials



Cobalt Chromium alloy



Stainless Steel



Titanium alloy



Idea Generation- Materials

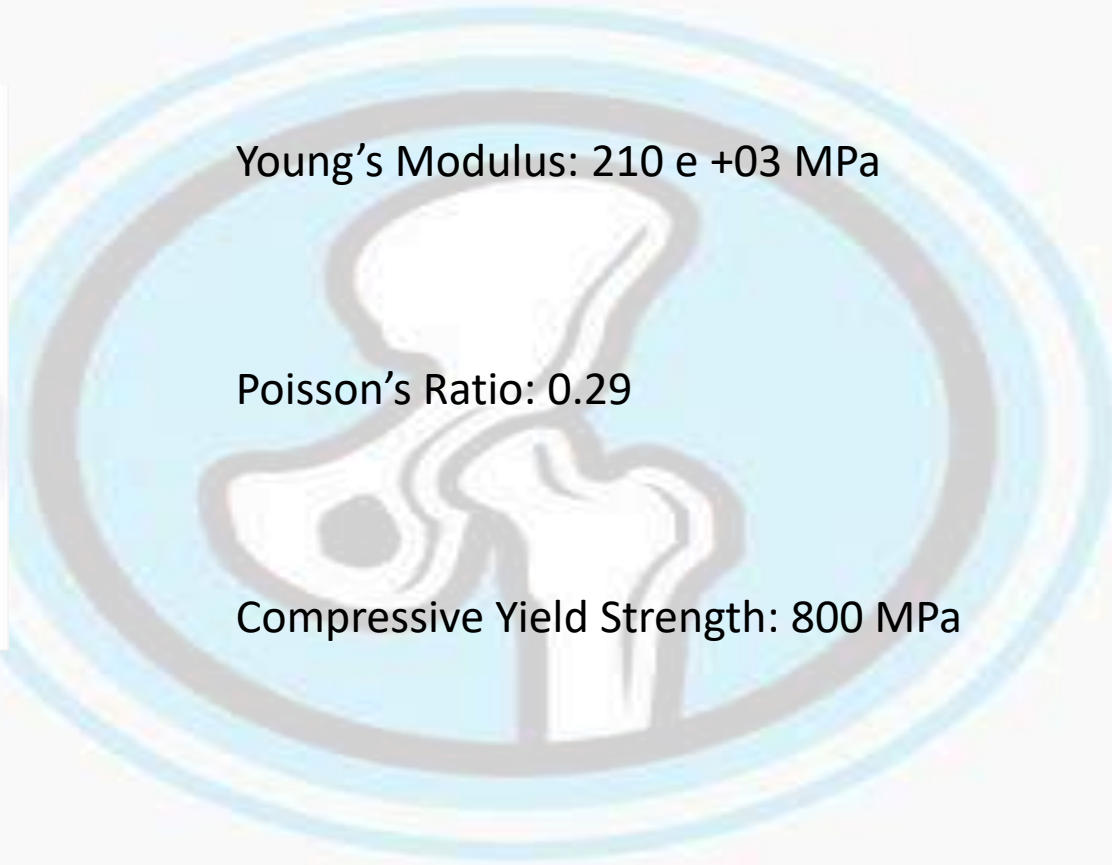


Cobalt Chromium alloy

Young's Modulus: 210×10^3 MPa

Poisson's Ratio: 0.29

Compressive Yield Strength: 800 MPa



Idea Generation- Materials



Stainless Steel

Young's Modulus: 193×10^3 MPa

Poisson's Ratio: 0.31

Compressive Yield Strength: 207 MPa



Idea Generation- Materials



Titanium Alloy

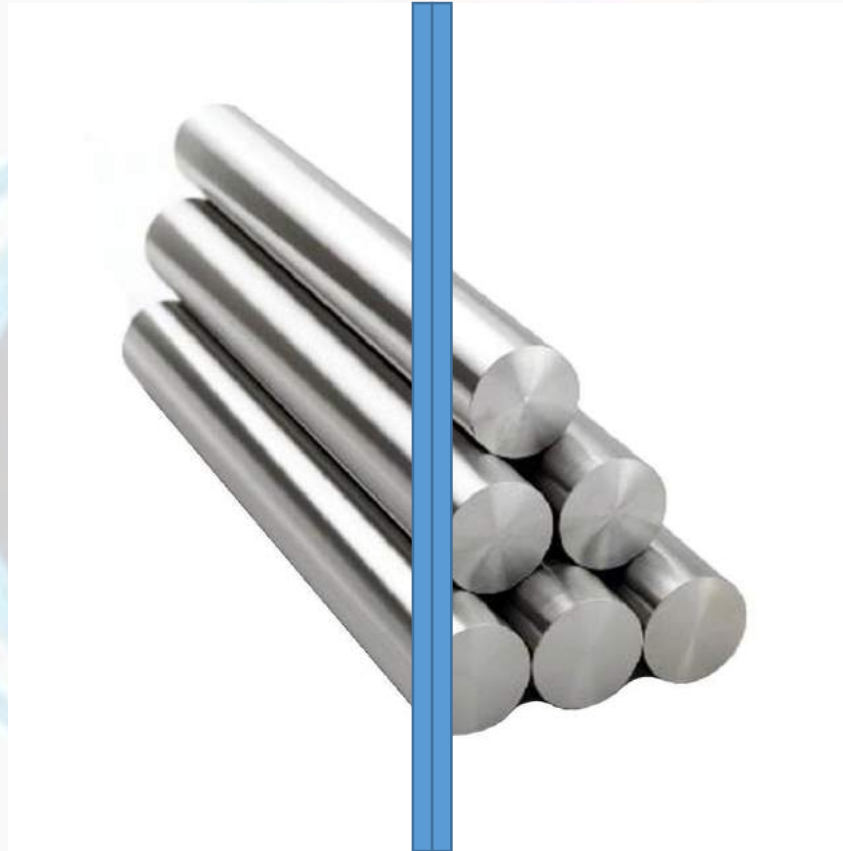
Young's Modulus: 96×10^3 MPa

Poisson's Ratio: 0.30

Compressive Yield Strength: 930 MPa



Idea Screening- Materials (Stem)



Titanium Alloy **Grade 5**



Orthopaedic Hip implant

Idea Screening- Materials (Ball)



Titanium Alloy **Grade 5**



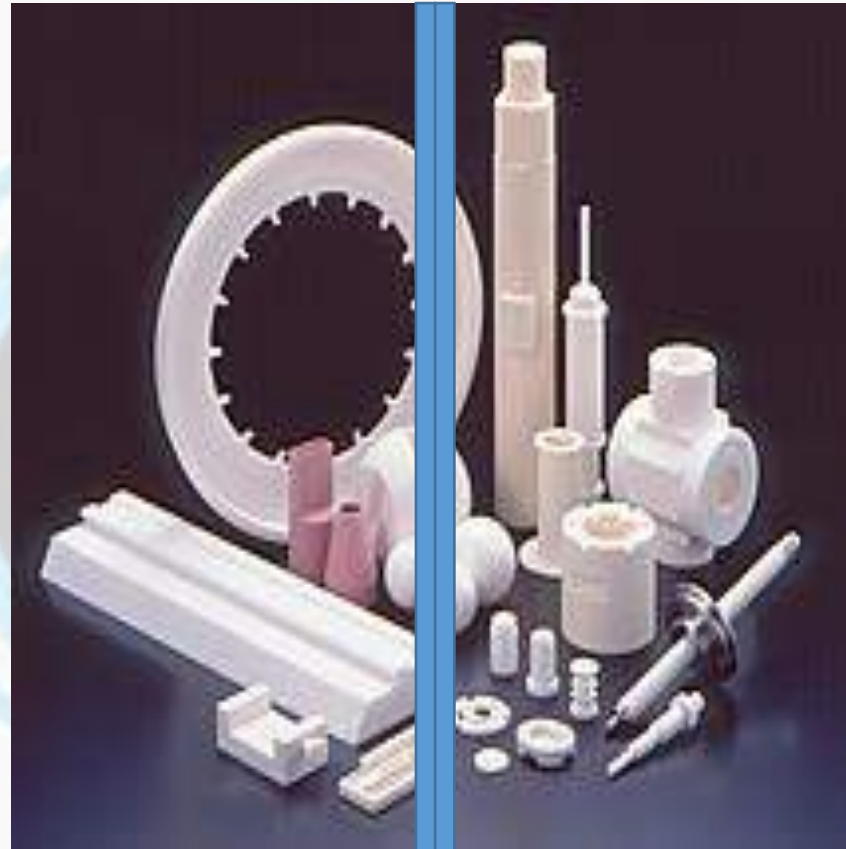
Idea Screening- Materials (Liner)



Polytetrafluoroethylene



Idea Screening- Materials (Cup)



Alumina ceramics (Aluminium oxide)



Testing (Analysis)

Fixed Support

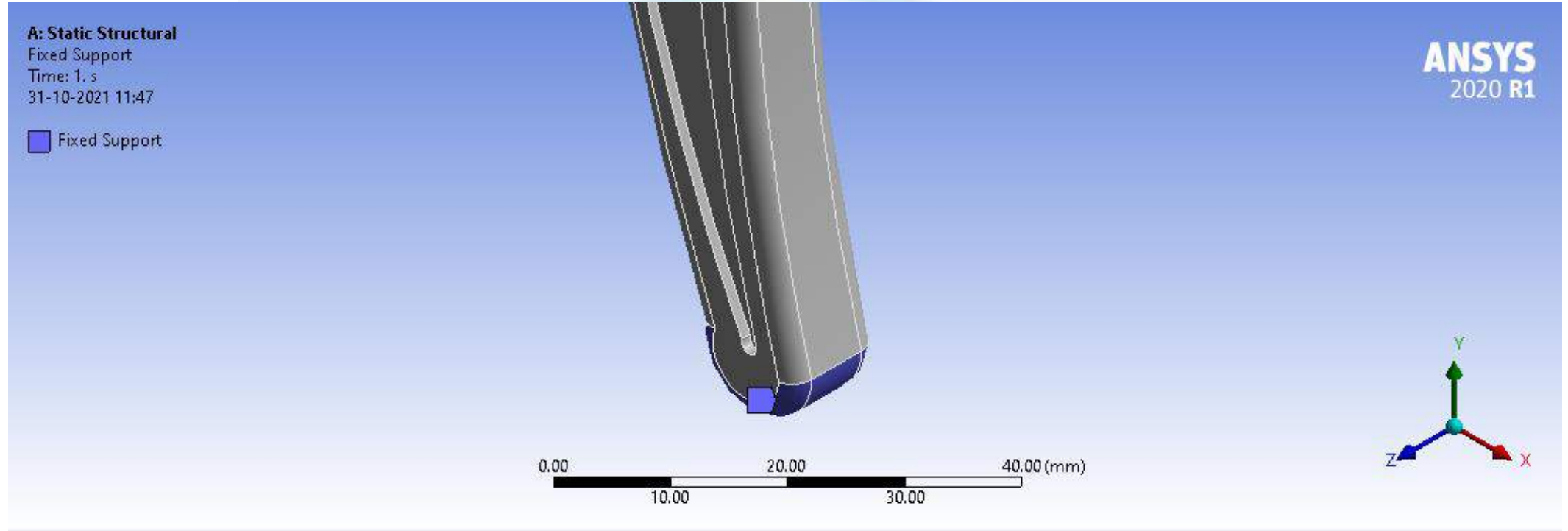
Applied Force

Total deformation

Equivalent (Von-Mises) Stress

Factor of Safety

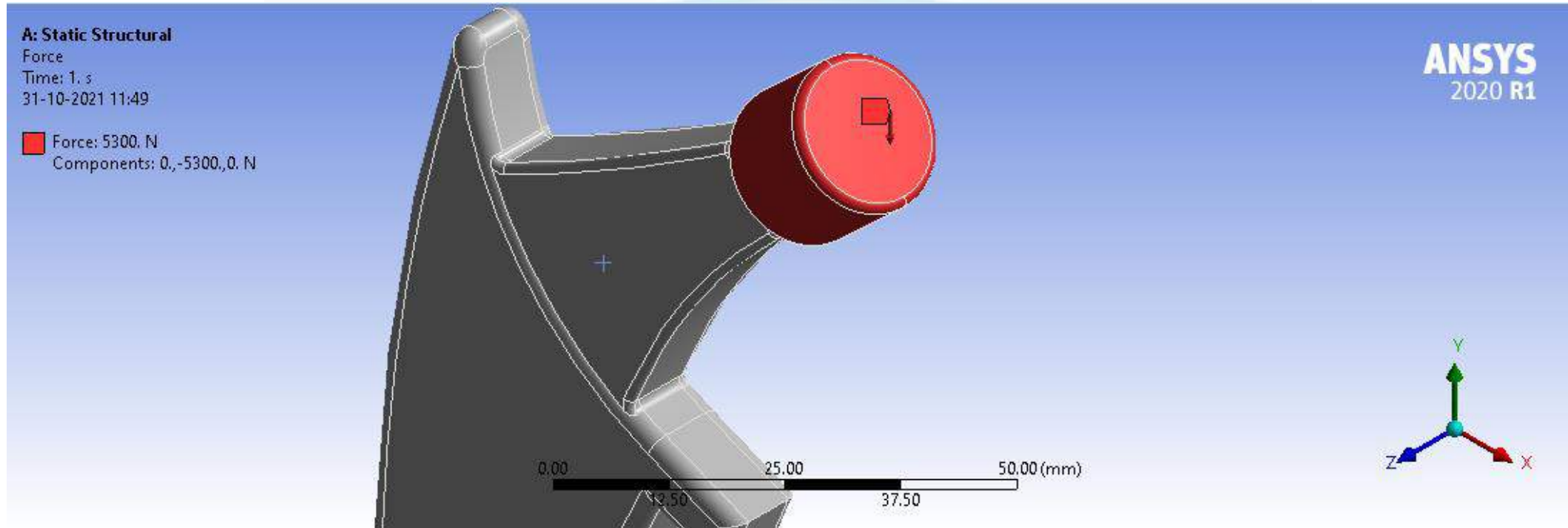




Fixed Support



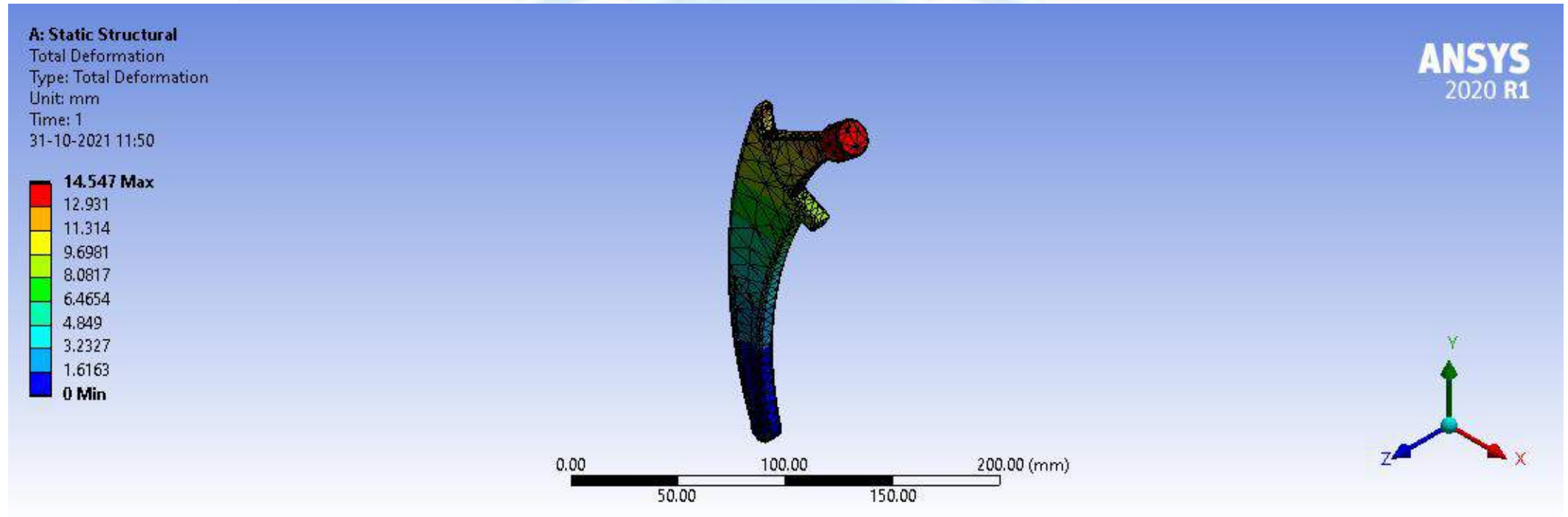
Testing (Analysis)



Applied Force of 5300 N

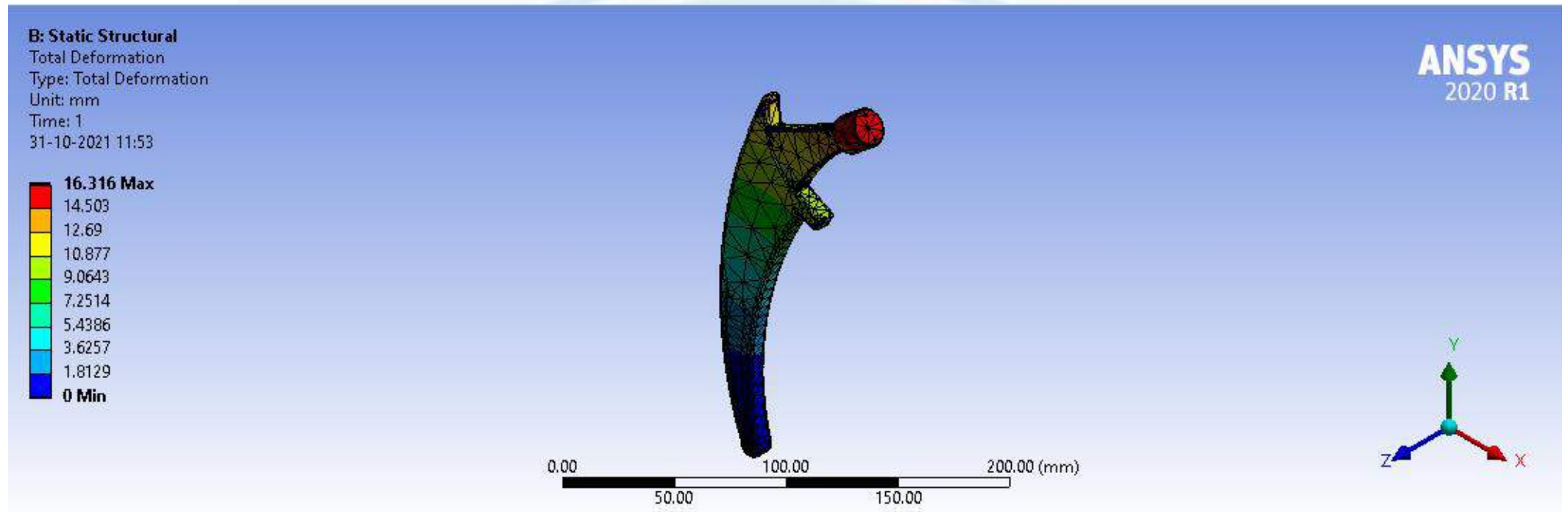


Orthopaedic Hip implant



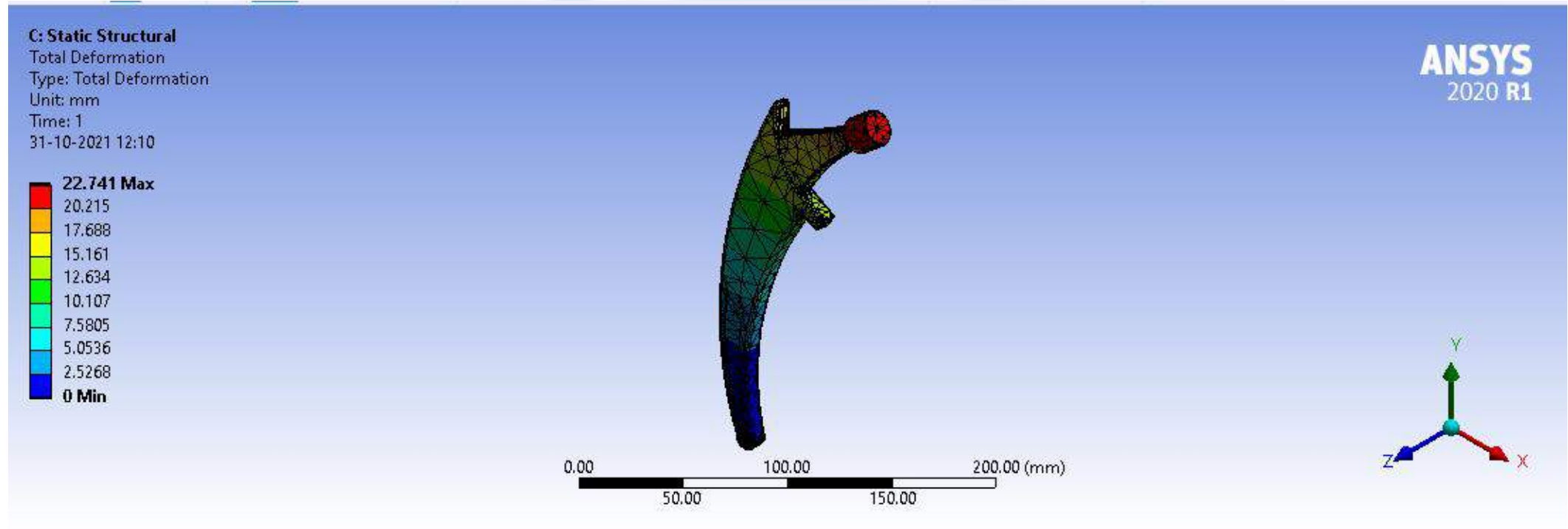
Total Deformation





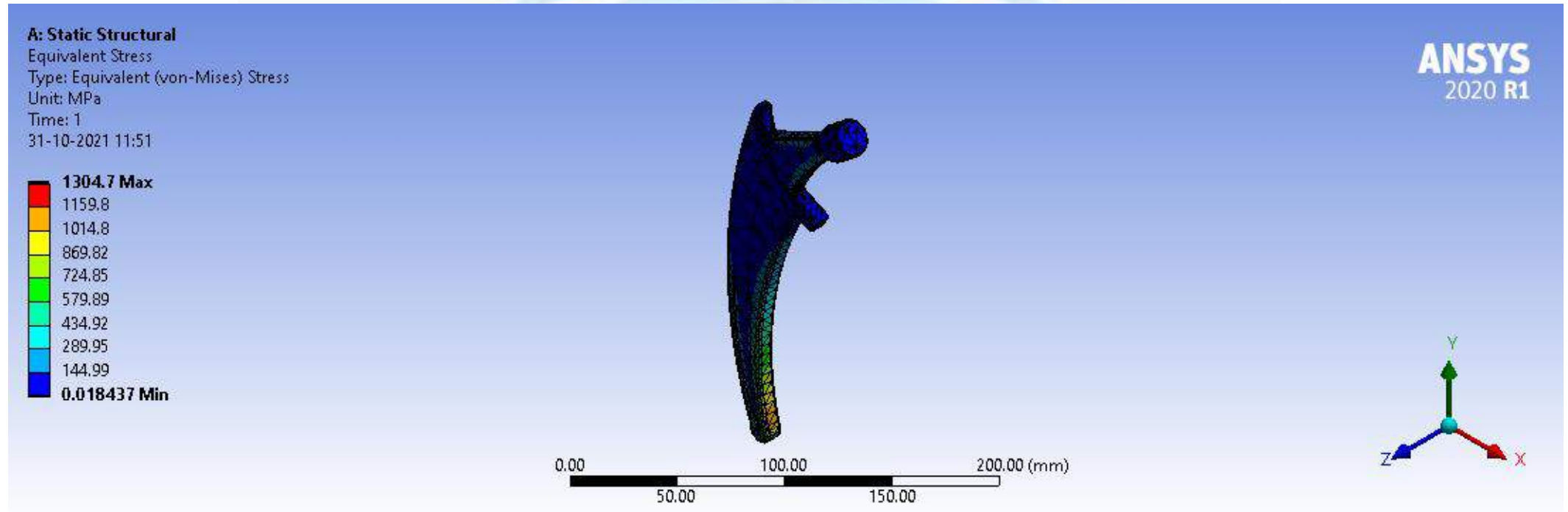
Total Deformation in 5 degree bended





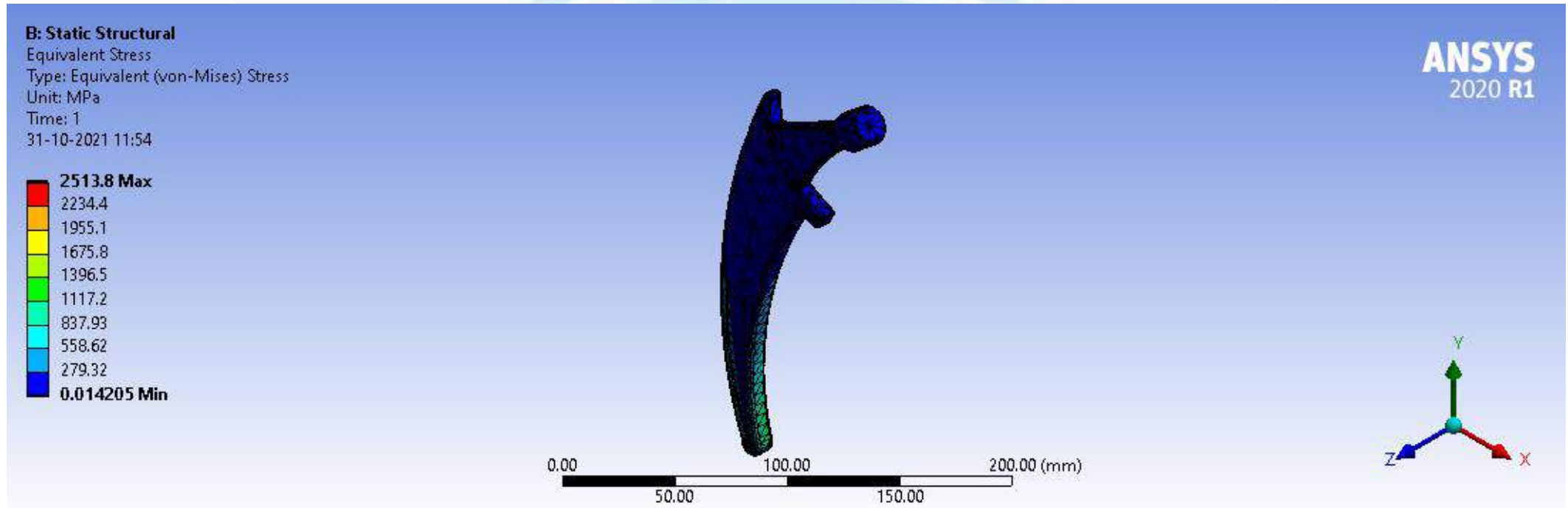
Total Deformation in 12 degree bended





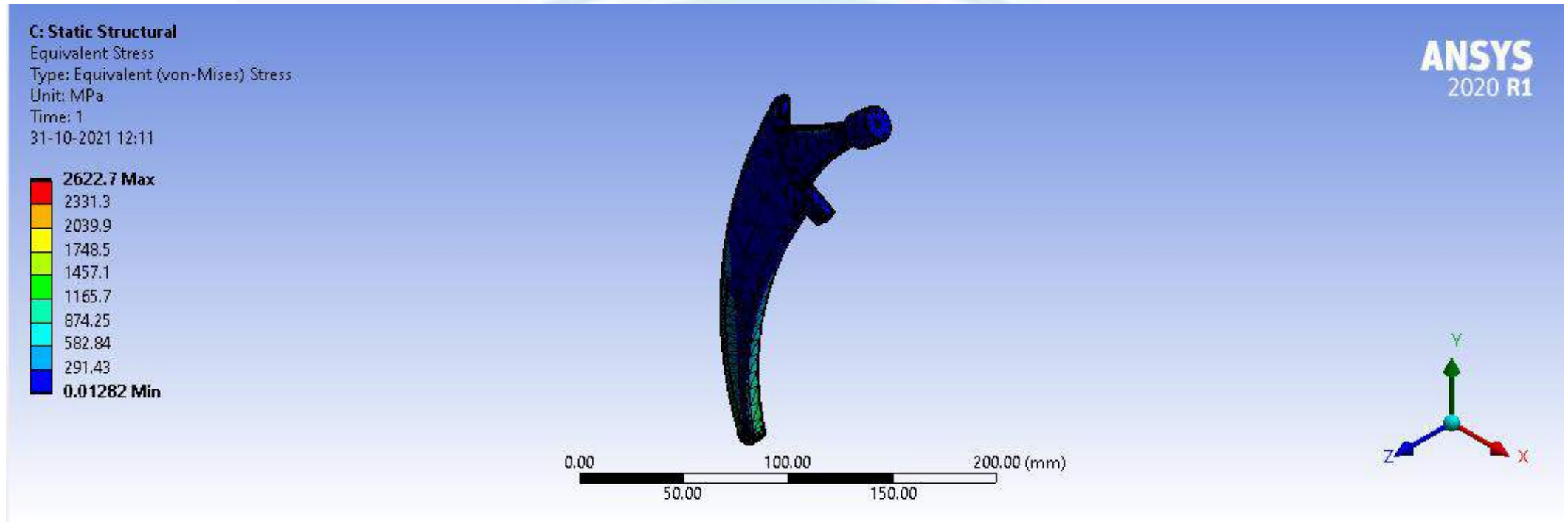
Equivalent (von-Mises) Stress





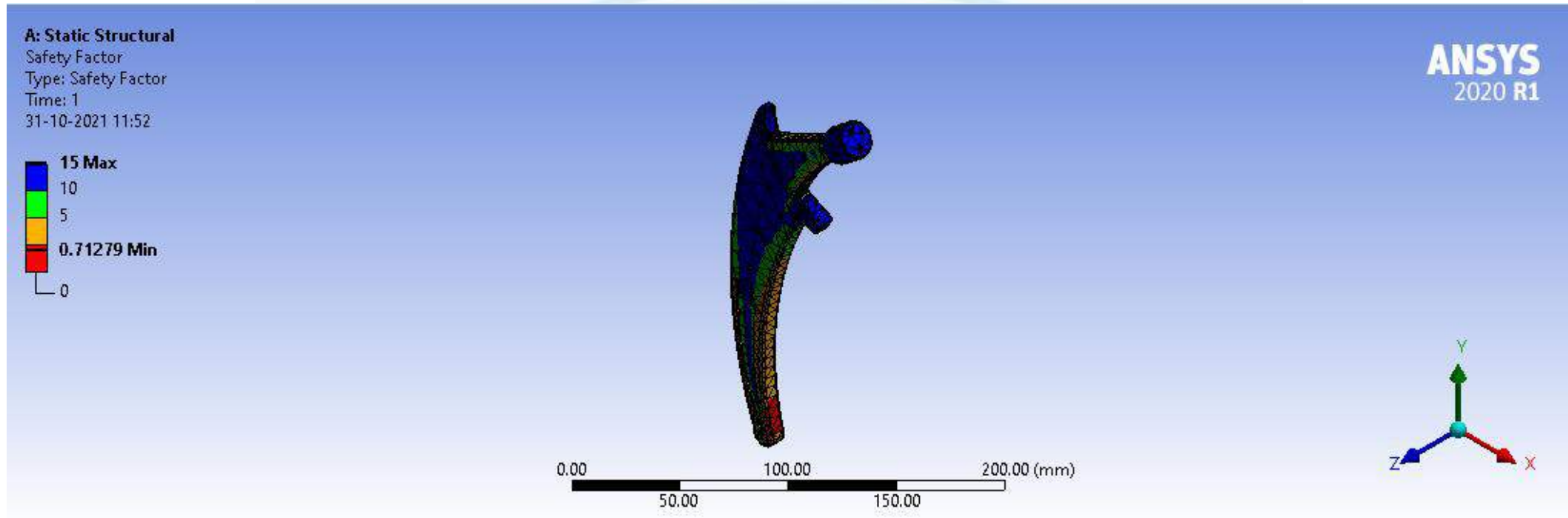
Equivalent (von-Mises) Stress in 5 degree bended





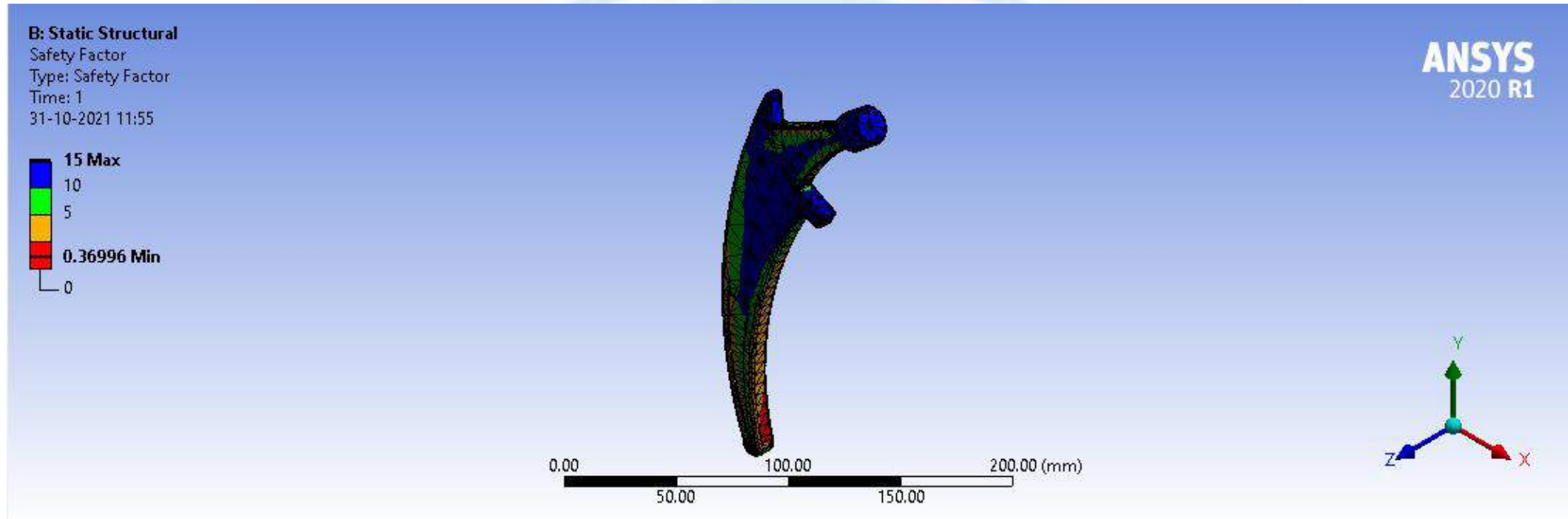
Equivalent (von-Mises) Stress in 12 degree bended





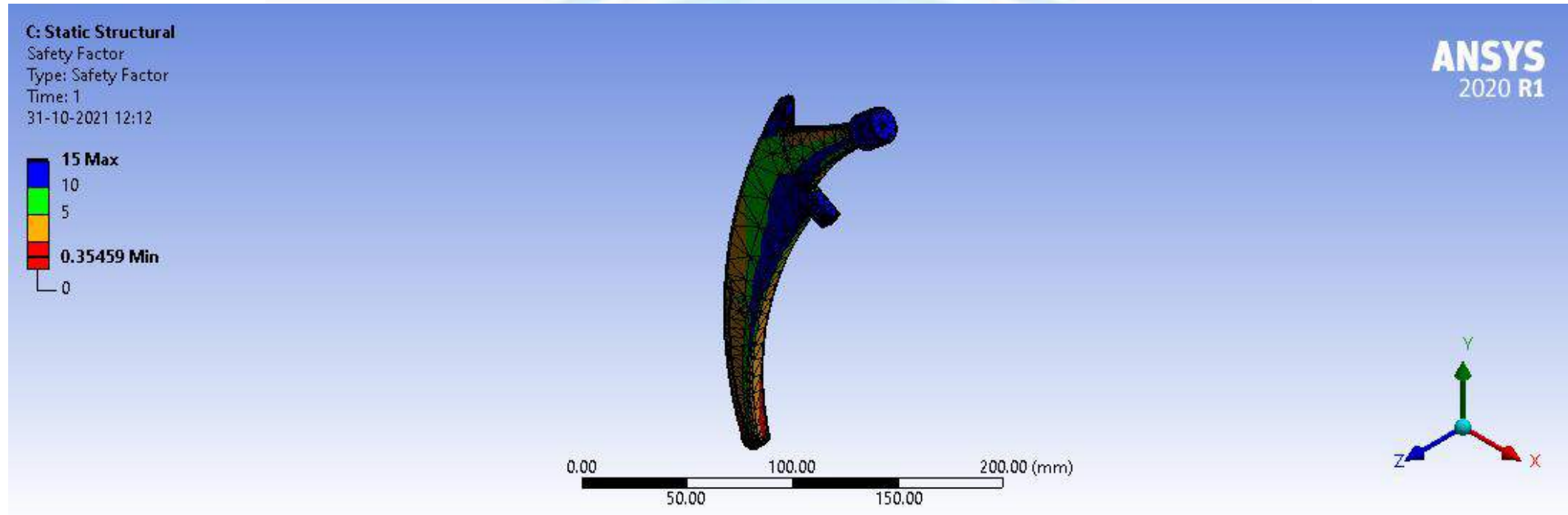
Factor of safety





Factor of safety with 5 degree bended





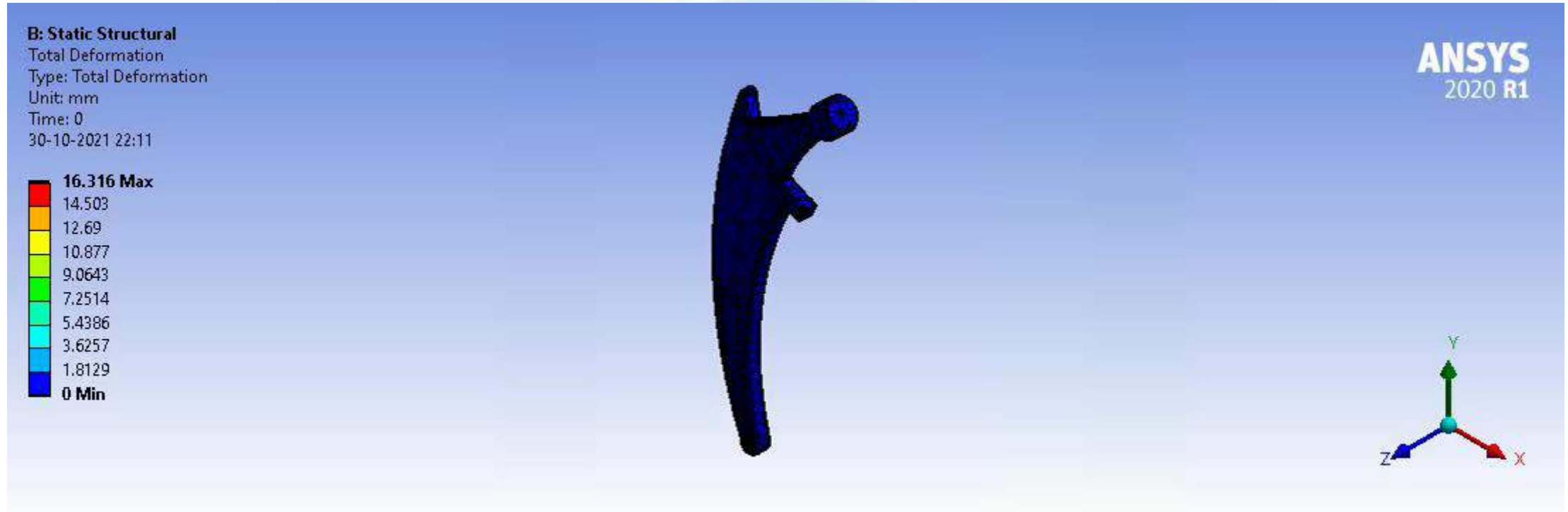
Factor of safety with 12 degree bended





Deformation of stem





Deformation of stem (5 degree)





Deformation of stem (12 degree)



Manufacturing of Stem



Forging

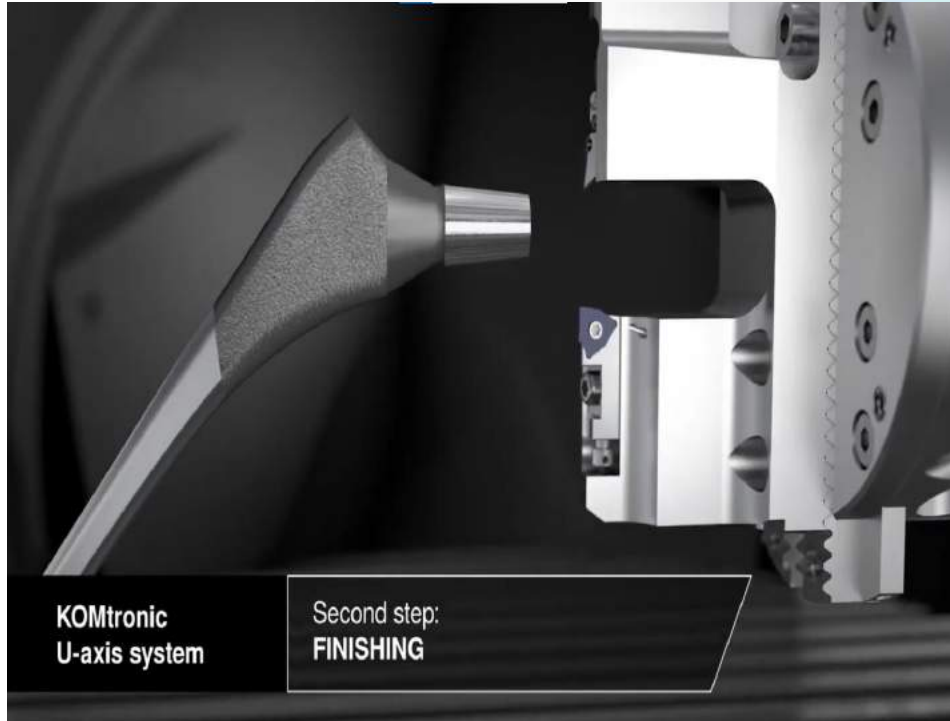


Investment Casting



Orthopaedic Hip implant

Manufacturing of Stem



Finishing



Coating



Manufacturing of Ball



FreeTurn

- Cutting edge follows the ball shape with the ideal angle setting
- Only one tool required
- Outstanding chip control
- Excellent shape accuracy



FreeTurn

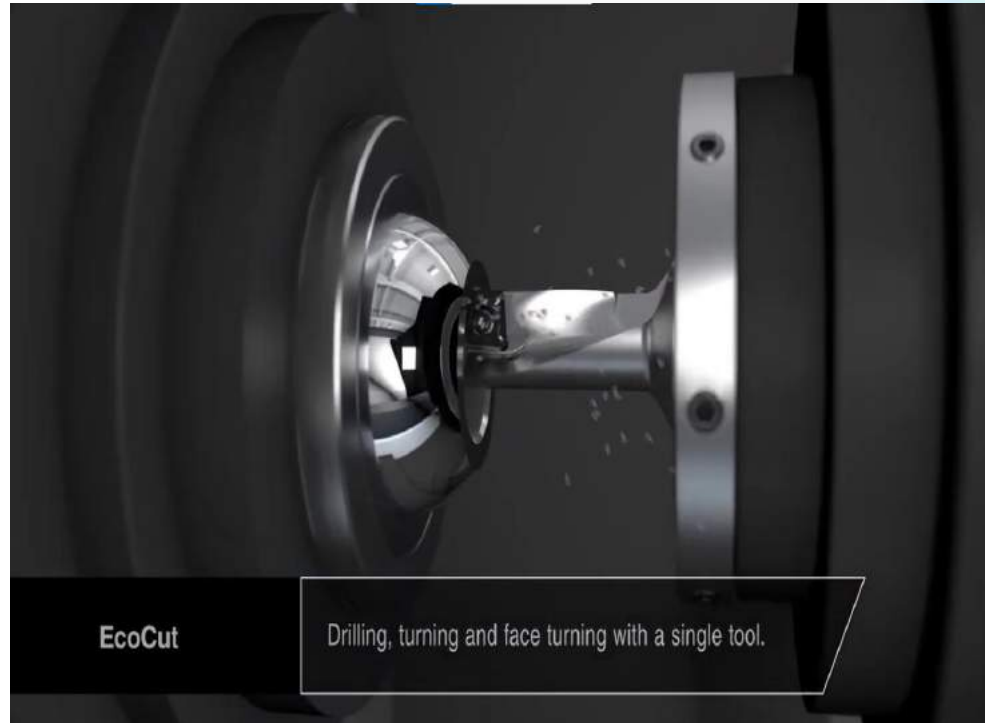
- Cutting edge follows the ball shape with the ideal angle setting
- Only one tool required
- Outstanding chip control
- Excellent shape accuracy

Turning



Orthopaedic Hip implant

Manufacturing of Ball



Turning



Reaming



Manufacturing of Liner



Injection Moulding



Orthopaedic Hip implant

Manufacturing of Cup



Moulding



Glazing

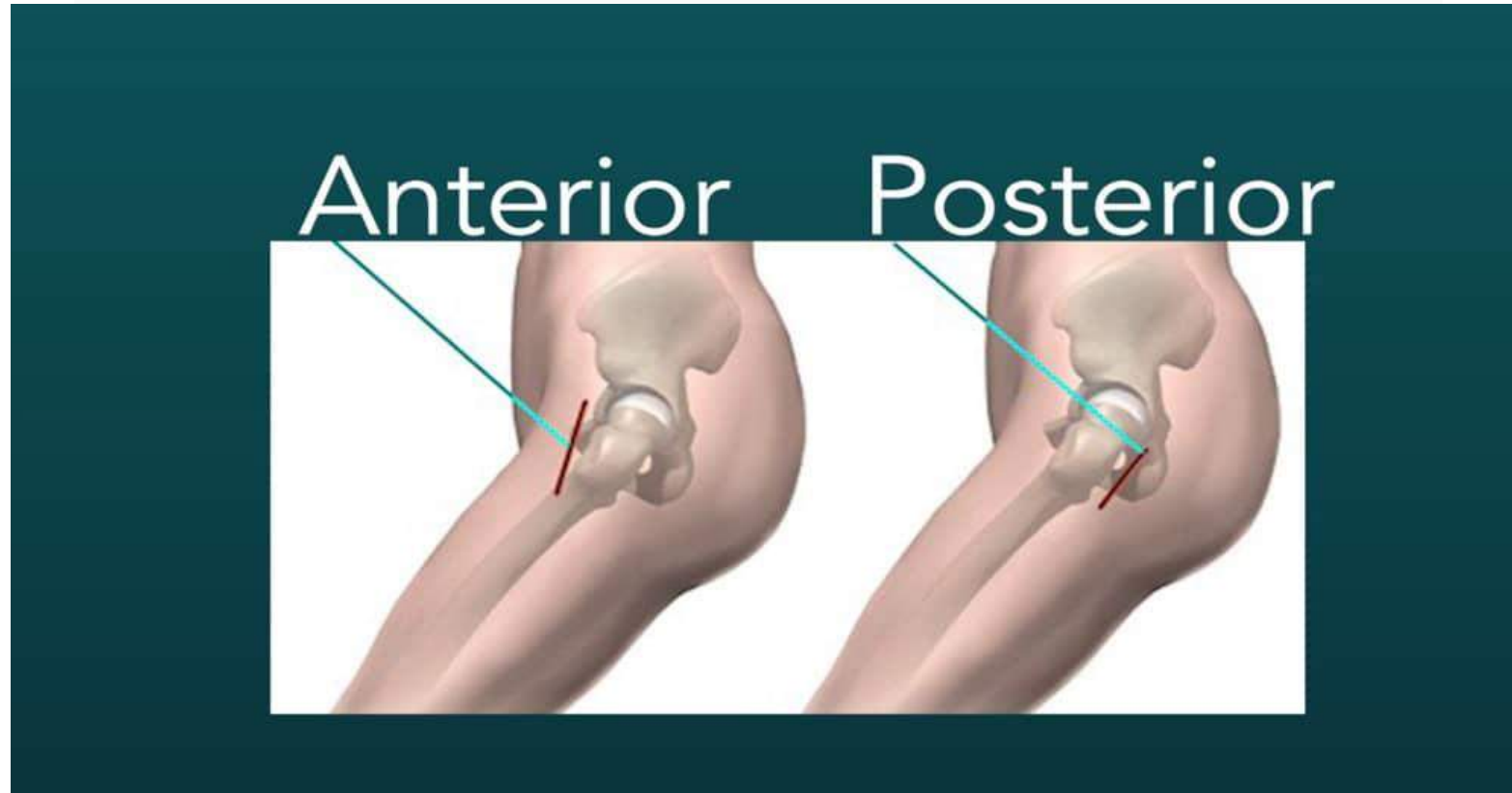


Manufacturing of Cup



Firing





Anterior and Posterior Approach



Tool required for surgery

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HANA TABLE



Orthopaedic Hip implant

Tool required for surgery

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Oscillating Saw



Reamer

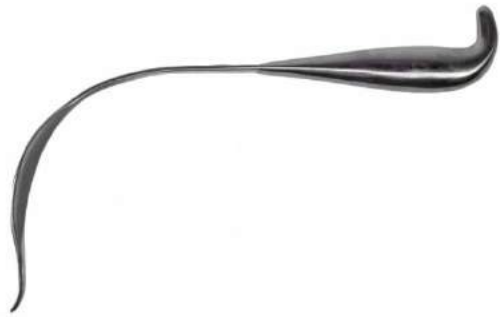


Reamer tool

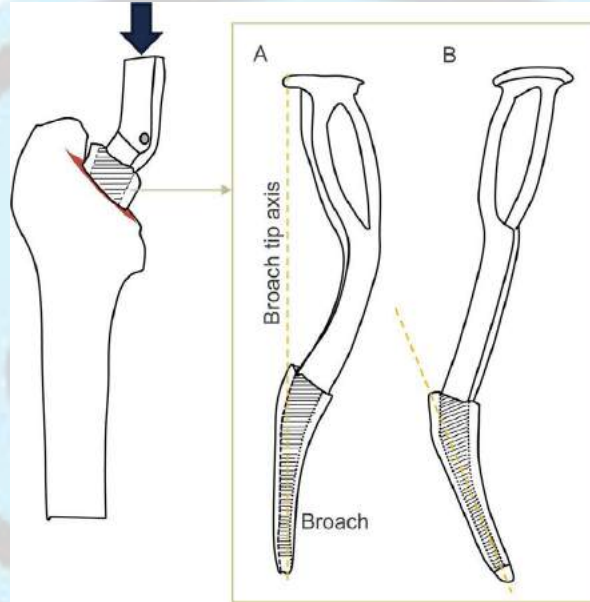


Orthopaedic Hip implant

Tool required for surgery



DEPUY cobra retractor



Broach Tool



K-nail retractor



Failure Mode Effective Analysis

Failure	Mode	Effective	Analysis
Fixation of patient to the operation table.	Ignoring the preparation step.	Fall of patient from the operation table.	Inclusion of experienced consultant.
Fixation of operation theatre.	Ignoring the preparation step.	Challenging in assembly.	Frequent Maintenance of HVAC.
Inadequate Machinery.	Poor Discriminate.	Loosing the patient.	Aware of Surprise and equipped fully.



Failure Mode Effective Analysis

Failure	Mode	Effective	Analysis
Tools failure.	High carbon content present in the tool.	Leads to other problems or promoting another surgery.	Proper maintenance of tool life.
Excess removal of bone.	Misguiding or quarrel between surgeons.	Improper plantation and promoting another surgery.	Valid brainstorming before the surgery.
Accidents.	Slippery floors, elimination of walker and External source.	Dislocation of Implant and leading to major surgery.	Following all advisory from the surgeons.



Failure Mode Effective Analysis

Failure	Mode	Effective	Analysis
Friction	Due to high working condition and elimination of adequate rest.	Deposition of powders in the liner(30 mg in 15 years) restrict the motion.	Coating MPC polymer in liner.
Dislocation of Implants.	Due to cross leg after posterior hip surgery.	Pain around the pelvis bone and femur bone.	Using chairs or cushion.
Dislocation of Implants.	Side way bending after posterior hip surgery.	Severe joint pain and bending around the stitched area.	Moving little steps.



Failure Mode Effective Analysis

Failure	Mode	Effective	Analysis
Dislocation of implant.	Turning the toe inwards after anterior hip surgery.	Severe pain around the joints and muscles.	Move the leg without turning the toe.
Dislocation of implant.	Immediate turning after surgery.	High stress in the joint and severe muscle pain.	Avoid sudden turn and use tool to perform immediate works.
Dislocation of implant.	Human bridging, Stretching and Exercise.	Severe pain in pelvis bone region and muscle pain.	Perform activities after physician advisory.



Failure Mode Effective Analysis

Failure	Mode	Effective	Analysis
Dislocation of implant.	Swimming or Fully submerged within 2-3 weeks of surgery.	Exposed of stitches and oozing of blood around the surgery area.	Wiping the body with hot water soaked towel.
Dislocation of implant.	Bending front after anterior hip surgery.	Severe acetabulum pain and muscle pain around the joint.	Splitting the leg and bend forward will minimise the pain.
Dislocation of implant.	Applying sudden brake or driving in a low seating position.	Sever pain in femur bone and muscle cramp.	Driving with good seating position will minimise the pain.



Future Developments

Developing the stem part with frictional texture(i.e. using animal pattern).

Proposing the consummate design with DFM(i.e. Design For Manufacturing) using ProCast and SolidCast.

Imposing **GD&T** for the consummate design (applying basic dimension in neck angle).

Evolve new material using material designer in ANSYS 2020 R1.

Accomplish the consummate design with **ISO 13485:2016 Quality management systems**.



References(Literature)

Impact of osteoarthritis: results of a nationwide survey of 10,000 patients consulting for OA

Finite Element Analysis of Orthopaedic Hip Implant with Functionally Graded Bioinspired Lattice Structures

Materials for Hip Prostheses: A Review of Wear and Loading Considerations

A Briefing on the Manufacture of Hip Joint Prostheses

Finite Element Analysis of Orthopaedic Hip Implant with Functionally Graded Bioinspired Lattice Structures



References(Video)

Challenges in Orthopaedic Implant Removal : Dr. B Shivashankar

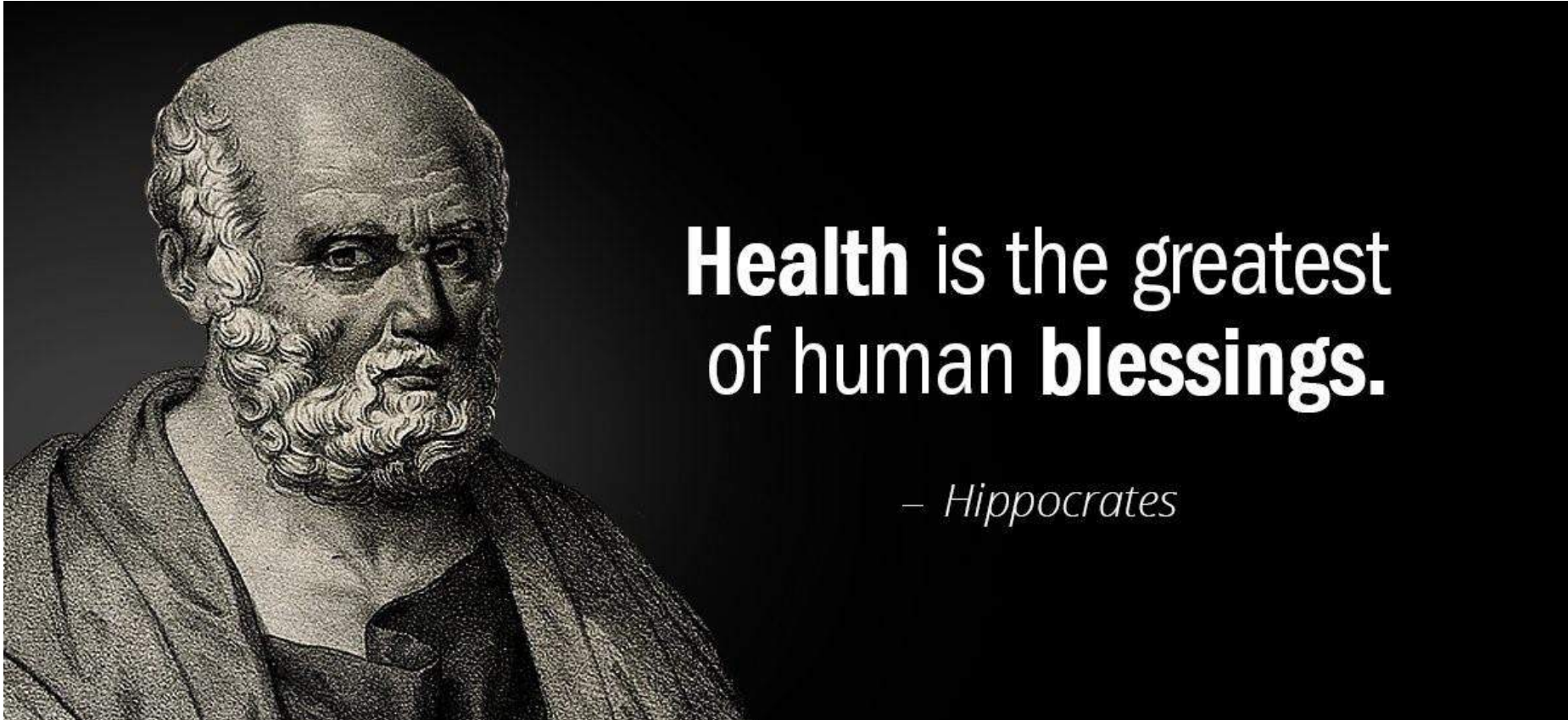
DON'T Make This Mistake After Hip Replacement Surgery

Artificial Hip Joints - Highly Precise and Economical Production Solution

The Latest Procedure: Anterior Approach Total Hip Replacement Surgery

New Longer Lasting Artificial Hip Joint





THANK YOU

