Using Python for Optimization and Conversion of STEP of CATIA and Converting it into MCNP (Monte Carlo N-Particle) Code

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Using Python for Optimization and Conversion of STEP of CATIA and Converting it into MCNP (Monte Carlo N-Particle) Code

Major Project

Submitted in partial fulfillment of the requirements

for the degree of

Master of Technology in Computer Science and Engineering(Networking Technologies)

Submitted By

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and

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May 2015

Certificate

This is to certify that the major project entitled **"Using Python for Optimization and Conversion of STEP of CATIA and Converting it into MCNP (Monte Carlo N-Particle) Code"** submitted by **Heema Vyas (Roll No:13MCEN29)**, towards the partial fulfillment of the requirements for the award of degree of Master of Technology in Network Technology (CSE) of Institute of Technology Nirma University, Ahmedabad, is the record of work carried out by him under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this project, to the best of my knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

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Statement of Originality

I, **Heema Vyas**, Roll. No. **13MCEN29**, give undertaking that the Major Project entitled "**Using Python for Optimization and Conversion of STEP of CATIA and Converting it into MCNP (Monte Carlo N-Particle) Code**" submitted by me, towards the partial fulfillment of the requirements for the degree of Master of Technology in Network Technology (CSE) of Institute of Technology, Nirma University, Ahmedabad, contains no material that has been awarded for any degree or diploma in any university or school in any territory to the best of my knowledge. It is the original work carried out by me and I give assurance that no attempt of plagiarism has been made. It contains no material that is previously published or written, except where reference has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

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Abstract

MCNP (Monte Carlo N-Particle Code) is used for the N-Particle coding that is used for observing and reading the particles like neutron, photon, electron or combination of The particles present inside any geometry structure.Constructing MCNP input file is very much complex as it is done manually and so is error-prone in describing geometry model, hence this thesis investigate into how to achieve the task of constructing proper given Geometry Structure and study on the particle and material present inside the structure and get the best result. Therefore the need arises of constructing proper Geometry Shape in some software and also designing and implementing an algorithm of conversion applied to generated file in some software and proper MCNP file.

In order to achieve the above goal, the software called CATIA which is known as Computer Aided Three-dimensional Interactive Application is used for designing the CAD geometry shape. CATIA offers a solution for designing different types of shapes and giving style to the shapes, also surfacing the work flow and to create visualization. CATIA is able to read and produce STEP format files therefore the design geometry is saved in form of STEP file. STEP File is known as exchange of data which is an intermediate file and is an information exchange standard produced by ISO that is International Standard Organization. It provides possibility in solving data exchanging and sharing between different CAD systems with an independent property. we designed an algorithm to achieve converting STEP file to MCNP INP file. The result of experiment shows that it has better applicability to convert STEP file to MCNP file.

Abbreviations

MCNP	Monte Carlo N-Particle.
CAD	Computer-aided design.
CATIA	Computer Aided Three-dimensional Interactive Application.
STEP File	Exchange of the data from one machine to another.

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Chapter 1

Introduction

1.1 General Purpose

The dissertation work is related to one software know as MCAM (Monte Carlo Modeling Interface Program) [1, 2] that has already been developed by FDS team. The development of the software called MCAM had been started since 1999, and its said that more than 100 person-years were invested in developing such wonderful software. The software is widely know as the converter for MCNP file. But there is need of developing similar kind of software so called converter for the Institution for Plasma Research (IPR) for examine only particular results in their experiments carried out by the researchers and scientist. There are few Scientist in the institution who are working on the MCNP related projects and they need particular things result like reading particles in the sens like how the particles collide with the atom of the material, at which angles, with what energies the particles emerges and material status in any Geometry Structure which are not satisfied by MCAM software. Thus taking this problem in consideration and satisfying their needs such type of software is developed.

MCNP (Monte Carlo N-Particle Code) [3, 4, 5] is used for the N-Particle coding that is used for observing and reading the particles like neutron, photon, electron or combination of The particles present inside any geometry structure. Constructing MCNP input file is very much complex as it is done manually and so it is said to be an error-prone in describing geometry model.

The history of MCNP introduced is as follows: the invention of Monte Carlo is given to the scientist called Fermi, von Neumann and Ulam. In the year 1947 the scientist

Fermi had invented a mechanical Device which was know as FERMIAC. Then in the year 1950 the scientist Ulam was the leader in creating MCS software. Later in year 1965 more of the interesting Features where added to MCS in order to produce the Monte Carlo neutron code that is know as MCN. Then in year 1973 the software called MCN and MCG are together joined to form MCNG, the predecessor of MCNP. Then in June 1977 the finally the MCNP is formed from the combination of all the codes.

The research done on the input file of MCNPs construction result's complexity and hence researchers, scientist and people working in MCNP filed always write the code manually. Writing code manually will lead to different outcome of input file coding of one particular geometry shape and hence there want be any neutral or particular input file generated to be followed for that particular shape. Thus it will lead to confusion for selecting the best input file for particular geometry. MCNP input file also has the problem in describing geometry model. Thus in order to overcome such situation in order to write it manually the CAD system has power functions in constructing desired geometry modeling, by doing this way like constructing MCNP model based on CAD system has a significant impact of the outcome of the result as required by the scientist. Therefore there is need to design and implement an algorithm that is used to convert general CAD model to MCNP model. In order to achieve the above goal on converting CAD model to MCNP model, the main focus was given to CATIA software.

CATIA is known as Computer Aided Three-dimensional Interactive Application[6]. The CATIA software helps in the creation of 3D shapes. CATIA was started and development in the year 1977. Direct conversion from CATIA software to MCNP is very much difficult hence there is one intermediate file called STEP file is generated. CATIA software is able to read and produce STEP format files and also STEP files is the most widely used data exchange [7, 8] and is an information exchange standard produced by ISO (International Standard Organization). The file extensions is (.stp). Thus the generated STEP file is converted to MCNP file by applying conversion algorithm.

CAD software has got many useful and powerful function in constructing geometric modeling, in order to achieve the MCNP aided modeling. There is a method called BREP (Boundary Representation) which is widely used in CAD model. It can be considered as an extension to the wire frame model. The BREP is divided into two types known as Topological and Geometric. The problem is that MCNP input file using the CSG

(Constructive Solid Geometry) representation method. CSG is a modeling technique that uses Boolean operations like union and intersection to combine 3D solids.

Hence, There is no such universal property that is occurring between the general CAD model and the MCNP input file. Thus,the transformation algorithm research between CAD model and modeling software is been developed. The only way found is constructing Geometry in CATIA software and save it in STEP file format and then applying conversion algorithm and getting MCNP file as a result. Like MCNP there are several MCNP aided modeling software which are as follows: Visual Editor, Moritz, DesignModeler etc which can realize MCNP software modeling, But there are several problems when using all model constructed by these software,like the model can not be imported into CAD software, difficulty to modify and unable to add materials information.

The General purpose of making such kind of the converter is to build the correct MCNP file of given structure and also to read and observe the activities of the particles present in the geometry structure.

1.2 Problem Statement

The software known as MCAM is used for converting into MCNP file [9]and also after getting converted to MCNP file helps in resulting required information needed by researchers and scientist, but the problem is that no such particular information is retrieved like reading and observing transportation or say activities of the particles present in the structure also how the particles collide with the atom of the material, at which angles, with what energies the particles emerges and also like reading material status in the structure. Hence to overcome such problem the software is developed that construct the structure in CATIA software and with the help of conversion algorithm converts to MCNP file. And also few extra features had been added.

Hence desired result is obtained by the scientist and researchers in their current working project.

1.3 Proposed System

In order to solve these problems, the main need is constructing Geometry Structure of required things like Fusion reactor, nuclear reactor,TF-coil,Tokamak etc. Thus in order to construct such Geometry Shapes CATIA software is used, after constructing shapes,

the file is saved in STEP file which based on ISO standard STEP standards do not rely on any system but a neutral mechanism, provides the feasibility of solving the exchange and sharing of data between different CAD systems. Now applying the conversion algorithm to that STEP File result into MCNP File.

The algorithm will try to first retrieve the required information from the STEP file in order to construct MCNP File. After extracting the information the Algorithm called Edge Cutting Method and Process its Linked Faces Method is applied. This is how the best result is obtained in form of MCNP File and required study and proper results on particles and material is also done.

1.4 Organization of the Project Work

The representation of the project work has been described chapter-wise in total seven chapters. The Chapter2 describes the various issues related to literature survey for the project work. It includes the detailed information related to MCAM and also few more software related to MCNP. The Chapter3 describes the software requirement and and specification, it includes the requirement of the system and also the software used. The Chapter4 describes the System Design, in which design is made for the software,how the conversion take place and also information related to STEP File and MCNP File. The Chapter5 describes the System Implementation which consist of the flow chart and the algorithm for the conversion. The Chapter6 describes the details of the experiments and result obtained. The last Chapter7 describes the summary of the project,Conclusion and Future Scope.

Chapter 2

Literature Survey

2.1 General

The main survey needed to be done on this project is related to software and algorithm. The survey has been done on software related to MCNP as assisted model. The following software related to MCNP are: Moritz, Visual Editor, Design Modeler, MCAM etc. The detailed description will be given below like how the software didn't worked properly as required. Next thing to which survey is done is Algorithm for conversion from STEP File to MCNP File.

2.2 Reviews of related works

1. **Related software:**

   Survey had been done on various software related to MCNP in various different ways.The following are the software:Moritz, Design Modeler, Visual Editor[10] and MCAM.

   Visual Editor:

   The survey done says that the software known as Visual Editor is the first Visual aid modeling software that is based on SAT file conversion. The file Type is ACIS SAT 3D Model File, They are saved using (.SAB) file format. The SAT format is used across many different industries, that mainly includes CAD and CAM. The most important say feature of visual is use of MCNP source code to read the input file of MCNP and accordingly to draw sectional view of model. Thus, such feature will ensure the consistency of any geometry model between the Visual Editor and

MCNP.

Moritz:

Another Survey has been done on Moritz, The Moritz geometry editor is used to construct and design different geometry models. In particular, it is widely used for computer games.

The Following are the main features of Moritz:

(a) Interactive Surface, Solid Body, and Cell creation and modification.

(b) 2D and 3D Viewing.

(c) Support of Solid bodies and macro bodies.

(d) Rapid processing of models for 3D display.

(e) It read's all or some part of additional MCNP input files with auto renumbering of cells and surfaces.

(f) Extensive user control over what is shown and how it is drawn.

(g) It Display's and shows animation effects of particle tracks in 3D and 2D.

(h) It also help in importing CAD drawings.

(i) It also support for Grid Tally meshes.

(j) Also the plotting of Mesh Tally data from mdata files can be done.

(k) Conversion of surface to solid body geometry Variables for surface and solid body coefficients.

(l) It shows the view of Static and animated 3D exploded.

(m) Translation and Duplication of selected cells or surfaces.

(n) Library for MCNP material definitions.

Design Modeler:

Then another survey had been done on the software know as Design Modeler. It is used as a geometry editor of existing CAD models. It is generally based on the solid model designing and as a result 2D Sketches, 3D Modeling, uploading 3D Modeling etc can be done. The Design Modeler distinguishes Dimensions which are as follows: Plane Dimension, Feature Dimension and Design Parameters.

Feature Dimension used to describe the dimensions of the structure or say model, that is the radius of the model, its shape, its length etc. Thus in short it can be said to be the feature representation of the model.

Plane Dimension used to describe the sketching of the model like defining and constructing edges of the model and also can add dimension at and time and also change it to generate different models.

Design Parameters is used to generate the design of any model defined. It helps in constructing the shape or model given and also assigns parameters to the model or shape that is constructed.

MCAM:

Last survey has been done on the MCAM software[11], it is the software that is developed by FDS team in Institute of Plasma Research of Chinese Academy of Sciences. The MCAM software is based on the C++ environment and also on ACIS geometry engine that is developed with Visual. The development of MCAM software was started in year 1999 and more than 100 person have been invested to built such a useful software. MCAM version 4.2 was bench marked with ITER (International Thermonuclear Experimental Reactor) benchmark model. The MCAM software includes the function like modeling,reading MCNP and constructing MCNP Geometry Structure.

2. **Related algorithms:**

The second important thing that is need to be study is the algorithm for conversion[12]. The conversion from CAD model to MCNP model. There are three types of algorithm mainly use for CAD to MCNP file conversion, which are as follows:

(a) The algorithm that is based on conversion of BREP to CGS representation.

(b) The algorithm that is based on constructing large three-dimensional CAD software.

(c) The algorithm that is based on conversion of neutral file called STEP file to MCNP file.

Conversion from BREP to CSG:

The survey has been done on the first algorithm that is conversion of BREP to CSG. BREP is know as boundary construction in solid modeling. These models are composed of two parts:Topology and Geometry, where the topology parts are divided into faces, edges and vertices's and geometry consist of surfaces, curves and points.

Constructive solid geometry (CSG) is a technique used in solid modeling. Contrast CSG with Surface mesh modeling and box modeling.

Based on this the FDS team has designed the algorithm that conversion "BREP to half-space representation". But this Conversion process leads to the issue that will involve a lot of feature recognition that has been researching all over and is an important and difficult issue. Hence the algorithm of conversion from BREP to CSG is not valid for constructing the software that is required. As the concept has been already used and also the conversion arises lot of challenges, and issues related to recognition of the features.

Constructing Large Three-Dimensional modeling CAD Software:

In order to explain the three dimensional modeling software survey has been done and with the help of example known as UG software has been explained in detail. The UG is the engineering based product, which is developed by Siemens PLM software Co-operation company. It helps in providing many varieties of the operating functions Secondary development of users. The users can try to carry UG OPEN API in order to get the functionality parts to meet the requirements of the clients. The figure shows how the UG model Topology is been constructed.

Thus, such type of the method is not only known by the limited developer's mathematical knowledge but also by the knowledge of computer graphics and judging whether the shell has been closed or not, hence this method is also not valid for the software.

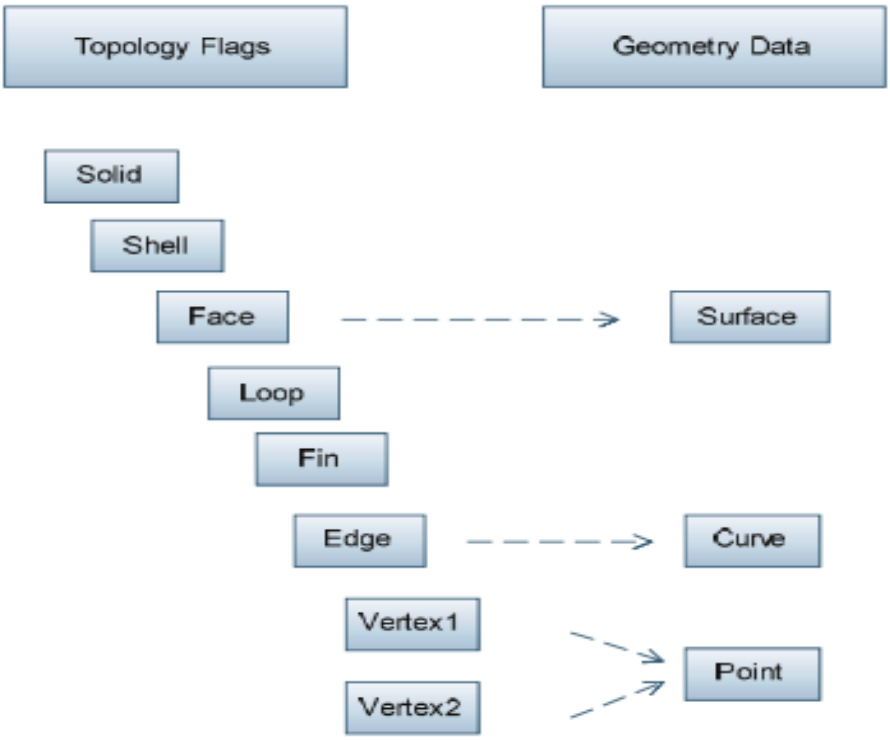


Figure 2.1: Model of UG Topology

Conversion Based on Neutral File (STEP) to MCNP file:

The survey has been done on the conversion using neutral file[13]. As the Geometry structure is constructed in the CAD software known as CATIA software Commonly referred to as a 3D shape designing.

This CATIA software has the format to save file in STEP file format, that is considered as the neutral file or say intermediate file for the conversion to MCNP file. Thus for the conversion an appropriate algorithm has been applied to the existing STEP File. This algorithm is not directly applied to the STEP File,but it applied to the STEP File extracted data. Thus later it gets converted into the MCNP file that is required as an output. Also the help of Step code library is required in order to extract the data from the STEP File. Thus after doing the survey this algorithm has been found reliable for converting the CAD Geometry files easily to MCNP File.

Chapter 3

SOFTWARE REQUIREMENT SPECIFICATION

3.1 Functional Overview

The Software requirements specification is one of the most important factor, that describes the different types of software that has been used in this project. Also what kind of the operating system used and also the operating environment. They are divided into two types called Functional and Non-functional requirements.

Functional requirements:

The Functional requirements in this project for user is to get the appropriate result of :

- Particle's activities
- Material present
- Volume of STEP and MCNP File

Non-Functional requirements:

Non-functional requirements, can be divided into two main categories:

- Qualities related to execution that defines security.
- Qualities related to Evolution that defines test-ability, maintainability, extendibility and scalability.

3.2 Operating environment

3.2.1 System Requirement

- Minimum 2GB of hard disk.
- Minimum 4GB of Random Access Memory(RAM).

3.2.2 Operating and Software Specification Requirements

- Ubuntu 12.04 using (Python) language.[operating system]
- CATIA Software.
- MCNP Software.

Ubuntu 12.04 using (Python) language:

The operating system used is Ubuntu 12.04, the reason behind this is that the MCNP input file mostly run on this operating system very easily with the help of the command line in Ubuntu. Even the commands required to develop the MCNP input file is easy and running those commands in terminals are also easily done. The important thing is that the Conversion algorithm has been done using the Python language having each different modules that describes each different classes,functions etc. The coding part mainly consist of the important things as describe:

- Geometry
  - Intermediate
  - MCNP
- Step Extractor
- STEP2MCNP Epsilon File
- STEP2MCNP Manager File
- STEP2MCNP Conversion File
- Main

The **Geometry** folder describes the Structure that is needed to be converted from STEP file to MCNP file, The folder consist of **Intermediate** folder that has all the files coded in python related to the concept of STEP File and where as another **MCNP** folder describes all the files coed in python related to concept MCNP File. Then comes the **Step Extractor** folder that defines how the input STEP file is extracted, means how the data is extracted from the given STEP FIle as input. Then file name **STEP2MCNP Epsilon** describes the concept regarding vectors. Then file name **STEP2MCNP Manager** describes the concept like how the MCNP file is managed. Then the file name **STEP2MCNP Conversion File** describes how the conversion take place from STEP to MCNP. The last one is **Main** file that works like the GUI.

CATIA Software:

The CATIA Software is mainly use in this project for constructing the required geometry shape as the CAD model is must for the starting step. All types of geometry shapes are first constructed with the given dimensions using CATIA software and Then later the file formed is saved in the STEP file format with the extension (.stp). Thus this STEP file is further used for the conversion.

MCNP Software:

The MCNP Software is used to examine the output file constructed after the conversion algorithm is applied to the input STEP File. The constructed MCNP File is tested in this software and hence the result generated will be in Geometry form along with the data needed by the users can be examined using various commands in MCNP software.

Chapter 4

SYSTEM DESIGN

The next step after software specifications is designing the system. The system or software need to be developed must be first designed properly so that the developer must get clear idea on developing algorithm and implementing it.

4.1 System Design

1. **Design for the STEP File:**

   (a) **Structure of STEP File**

   The STEP File is a standardized file format that is used in graphic exchange. STEP-File is the most widely used data exchange form of STEP. The file extensions is (.stp).

   The STEP File consist of two segments: Header Segment and DATA Segment. The Header Segment consist of the information related to the STEP converter that is its version and also three dimensional modeling cad software.The DATA Segment consist of the the entity definition of geometry and data elements. In this data segments there are many division found in the geometry entity where each instances has the unique ID Number(# N,N as a positive integer) or a pointer. This explains that the ID is followed by the data element, inside the bracket is the entity instances data behind the data element. one of the benefit is that the entity instances can be mutually nested and is called the geometry entity or the characteristics of entities.

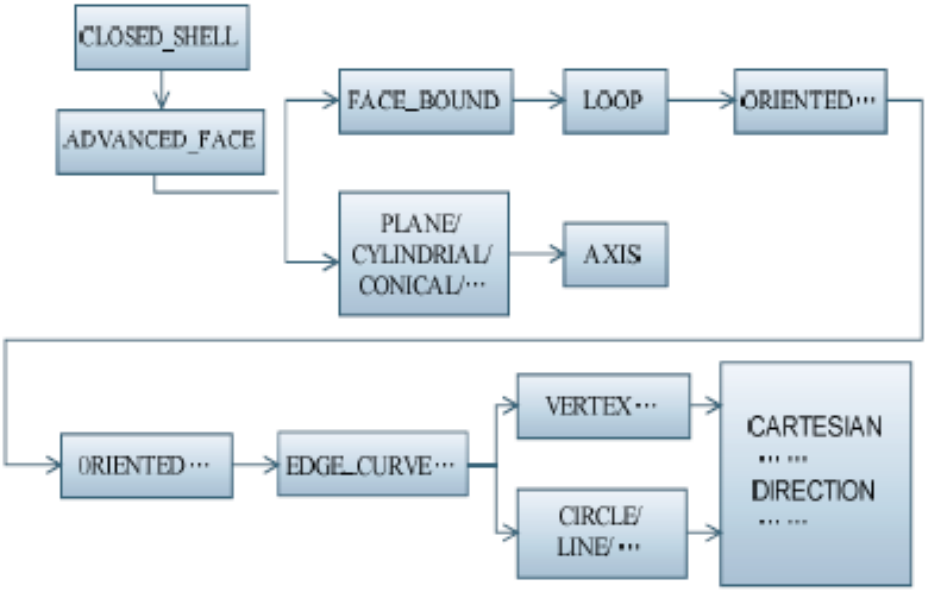


Figure 4.1: Structure of STEP file

- CLOSED-SHELL is the main starting of the STEP File and it consist or say defines the set of the Planes that constructs the geometry. dimensional geometric space.
- ADVANCED-FACE comes under the closed shell, that is nothing but a type of the surface which try to form certain geometry like a boundary and vertex.
- FACE-BOUND is nothing but is a closed boundary plane.
- EDGE-LOOP is the expression of the closed orbit having the starting point and end point,it also contains the face bound.
- ORIENTED-EDGE is the border that consist of the Edge-Curve like line,arcs and also has the differences in orientation.
- EDGE-CURVE is the representation of the geometry boundary outline and has no orientation.
- VERTEX-POINT clearly represents the vertices's of any geometry.
- CARTESIAN-POINT is nothing but the so called co-ordinates that is defined inside the brackets as is the value that represents the Cartesian co-ordinate system.

(b) **Extraction of the data from STEP FIle**

In order to extract the data from the STEP file, the first thing is to understand the required data for creating MCNP Input File. Thus with the help of STEP Code Library its easy to extract the useful data from the STEP file.

The main things that is needed to be extracted from STEP file is the Closed Shell followed with the ADVANCE FACE and then followed with the surface. It should then extract the three important data know as CARTESIAN POINT,DIRECTION and X-DIRECTION.

2. **Design for MCNP File:**

MCNP(Monte Carlo N-Particle)[9, 14] tries to treat problem geometry primarily in terms of regions or volume bounded by surface. MCNP always uses (x, y, z) Cartesian coordinate system and has dimensions measured in centimeters (cm). The following figure shows the description of the MCNP input file format:

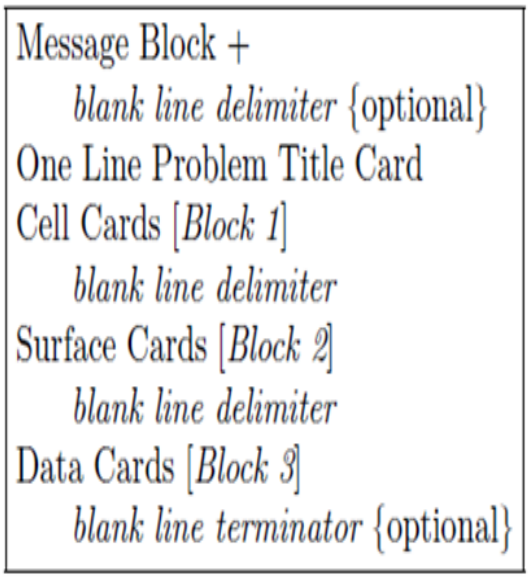


Figure 4.2: Structure of MCNP input file

- **CELL BLOCK**

The Cell Block mostly define the cell allocation in the geometry structure which are formed by the intersections, unions and complements. The cell block consist of following things:

1. A unique number or index that has the cell Range [1 to 99999].
2. To identify the material in the cell and its density a pair of numbers are assigned.
3. To define the geometry of the cell a combination of surface numbers is assigned.

The regions are also combined by Boolean operators that is:
Intersection: ( ) Space Symbol
Union: ( ) Semicolon Symbol
Complement: (#) Hash Symbol

In the Cell Block we have three different types of the cell known as void cell, material cell, outer void cell.

1. Void cell is defined by 0.
2. Material cell defined by 1.
3. Outer void cell defined by 2.

Also the importance of the particles like neutron proton and electron present inside the Geometry Structure are defined in the given region as:

1. IMP:N=0 IMP:P=0 indicates zero weight age of neutron and proton particles.
2. IMP:N=1 IMP:P=0 indicates 1 unit of neutron and zero weight age proton particles.
3. IMP:N=0 IMP:P=1 indicates zero weight age of neutron and 1 unit proton particles.
4. IMP:N=1 IMP:P=1 indicates 1 unit weight age of neutron and proton particles.

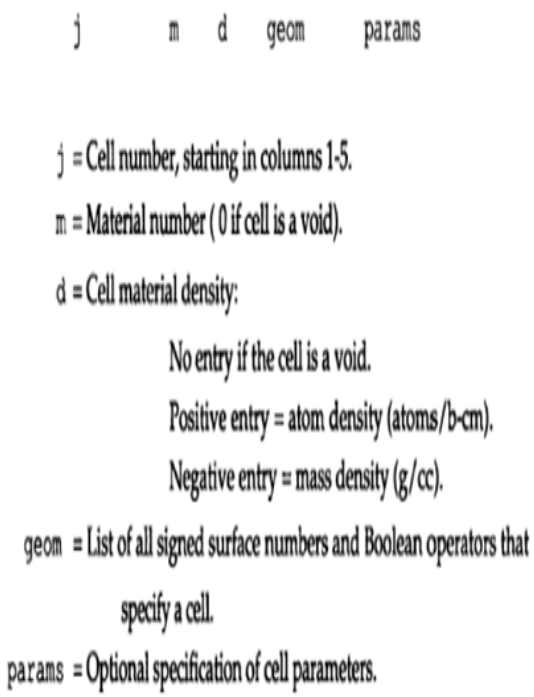


Figure 4.3: Structure of Cell Block

- **SURFACE BLOCK**

  The Surface Block consist of the surfaces of the Geometry Structure. Surface Block mostly starts with the columns [1-5]. The surface block generally defines the surfaces of basic shapes known as Plane, Sphere, Cone, Cylinder, Torus etc. The surface formula's of different shapes are already defined in the figure that is described, where we have the defined surfaces in different Cartesian in first column then followed with the next column the type of the shapes, then followed with the description of the shapes with Cartesian as to whether its general or parallel to different axis. Then next column follows the actual equation that are not consider for MCNP calculation. The last column defines the Card Entries that actually describe the MCNP equation need to be calculated.

Mnemonic	Type	Description	Equation	Card Entries
P	plane	general	$Ax + By + Cz - D = 0$	$A\ B\ C\ D$
PX		normal to x-axis	$x - D = 0$	D
PY		normal to y-axis	$y - D = 0$	D
PZ		normal to z-axis	$z - D = 0$	D
SO	sphere	centered at origin	$x^2 + y^2 + z^2 - R^2 = 0$	R
S		general	$(x-x)^2 + (y-y)^2 + (z-z)^2 - R^2 = 0$	$x\ y\ z\ R$
SX		centered on x-axis	$(x-x)^2 + y^2 + z^2 - R^2 = 0$	$x\ R$
SY		centered on y-axis	$x^2 + (y-y)^2 + z^2 - R^2 = 0$	$y\ R$
SZ		centered on z-axis	$x^2 + y^2 + (z-z)^2 - R^2 = 0$	$z\ R$
C/X	cylinder	parallel to x-axis	$(y-y)^2 + (z-z)^2 - R^2 = 0$	$y\ z\ R$
C/Y		parallel to y-axis	$(x-x)^2 + (z-z)^2 - R^2 = 0$	$x\ z\ R$
C/Z		parallel to z-axis	$(x-x)^2 + (y-y)^2 - R^2 = 0$	$x\ y\ R$
CX		on x-axis	$y^2 + z^2 - R^2 = 0$	R
CY		on y-axis	$x^2 + z^2 - R^2 = 0$	R
CZ		on z-axis	$x^2 + y^2 - R^2 = 0$	R
K/X	cone	parallel to x-axis	$\sqrt{(y-y)^2 + (z-z)^2} - t(x-x) = 0$	$x\ y\ z\ t^2\ \pm 1$
K/Y		parallel to y-axis	$\sqrt{(x-x)^2 + (z-z)^2} - t(y-y) = 0$	$x y\ z\ t^2\ \pm 1$
K/Z		parallel to z-axis	$\sqrt{(x-x)^2 + (y-y)^2} - t(z-z) = 0$	$x y\ z\ t^2\ \pm 1$
KX		on x-axis	$\sqrt{y^2 + z^2} - t(x-x) = 0$	$x\ t^2\ \pm 1$
KY		on y-axis	$\sqrt{x^2 + z^2} - t(y-y) = 0$	$y\ t^2\ \pm 1$
KZ		on z-axis	$\sqrt{x^2 + y^2} - t(z-z) = 0$	$z\ t^2\ \pm 1$
			± 1 used only for 1-sheet cone	
SQ	ellipsoid hyperboloid paraboloid	axis parallel to x-, y-, or z-axis	$A(x-x)^2 + B(y-y)^2 + C(z-z)^2 + 2D(x-x) + 2E(y-y) + 2F(z-z) + G = 0$	$A\ B\ C\ D\ E\ F\ G\ x\ y\ z$
GQ	cylinder, cone ellipsoid paraboloid hyperboloid	axis not parallel to x-, y-, or z-axis	$Ax^2 + By^2 + Cz^2 + Dxy + Eyz + Fzx + Gz + Hy + Jz + K = 0$	$A\ B\ C\ D\ E\ F\ G\ H\ J\ K$
TX	elliptical or circular torus. Axis is parallel to x-, y-, or z-axis	$(x-x)^2/B^2 + (\sqrt{(y-y)^2 + (z-z)^2} - A)^2/C^2 - 1 = 0$		$x\ y\ z A\ B\ C$
TY		$(y-y)^2/B^2 + (\sqrt{(x-x)^2 + (z-z)^2} - A)^2/C^2 - 1 = 0$		$x\ y\ z A\ B\ C$
TZ		$(z-z)^2/B^2 + (\sqrt{(x-x)^2 + (y-y)^2} - A)^2/C^2 - 1 = 0$		$x\ y\ z A\ B\ C$
XYZP	surfaces defined by points – see pages 3-15 to 3-17			

Figure 4.4: Structure of Surface Block

- **DATA BLOCK**

The third block is known as the data block that is used to give the detailed description of the Geometry Structure that has been defined. This block of input cards defines:

1) Neutron, Proton and Electron types.

2) Arising problems in the material present in structure.

3) the sources that are related to radiations.

4) The result needed to be tallied.

5) Study the interaction levels of the particles.

6) Different techniques related to the variances.

7) The last is checking the output result.

Thus we can describe in short that the Data block provide almost all the descriptions and problems related to the geometry.

Also the Data block consist of the four other important part that will define the type of the material and its related information. The following are the four important type of Data Block that are:

1. Material Specification.
2. Cross Sectional Specification.
3. Source Specification.
4. Tally.

The detailed description of these important Data Block Specifications areas given below along with its related examples.

1. Material Specification

   Material Specification is used to define the types of material present inside the Geometry Structure and is defined in the following way:

   (a) To define material number as unique.

   (b) The composition of isotropic.

   (c) Also related to cross section used.

2. Cross Section Specification

   The cross sections are used in few instances that are available for the elements with naturally occurring atomic abundances. Sometimes natural elements need to be put together from isotopes.

3. Source Specification

   The third important part is the source specification and the type of the radiation particles for an MCNP problem are specified by the SDEF command.

   The example explains,The command line starts with SDEF command followed by ERG=1.5 that explains the energy is 1.5 MeV and followed by PAR=2 which explains that the particle type is 2, then followed by the POS=d5 explains the position, that is the location. Then the next line indicates the [x y z] co-ordinates of the two point sources. The next line explains the relative strength of each of the sources that is defined.

4. Tally Specification

   The fourth important of the data block is the Tally Specification, Types of tallies available in MCNP and always denoted by pl. The following figure explains the detail information about tally. There has been less use of the Tally Specification.

Mneumonic	Tally Type	particles *pl*	Fn Units	*Fn Units
F1:*pl*	surface current	N or P or N,P or E	#	MeV
F2:*pl*	average surface flux	N or P or N,P or E	#/cm^2	MeV/cm^2
F4:*pl*	average flux in a cell	N or P or N,P or E	#/cm^2	MeV/cm^2
FMESH4:*pl*	track-length tally over 3D mesh	N or P or E	#/cm^2	MeV/cm^2
F5a:*pl*	flux at a point or ring	N or P	#/cm^2	MeV/cm^2
FIP5:*pl*	pin-hole flux image	N or P	#/cm^2	MeV/cm^2
FIR5:*pl*	planar radiograph flux image	N or P	#/cm^2	MeV/cm^2
FIC5:*pl*	cylindrical radiograph flux image	N or P	#/cm^2	MeV/cm^2
F6:*pl*	energy deposition	N or P or N,P	MeV/g	jerks/g
F7:*pl*	fission energy deposition in a cell	N	MeV/g	jerks/g
F8:*pl*	pulse height distribution in a cell	P or E or P,E	pulses	MeV

Figure 4.5: Structure of Tally Specification

- **Design for the Conversion Software:**

  The design for building the software of conversion from STEP file to MCNP File is shown in the figure and works in the following way:

  - First the generated STEP File from the CATIA Software is taken as the input file.
  - Then with the help of the Step Code library the required information like Geometry and Topological for conversion is extracted.
  - Then the extracted data are reconstructed and optimized. item Then after conversion algorithm that has been explained detail in chapter5,is applied on the extracted data and it forms INP File that is nothing but MCNP File.
  - Thus this is how the MCNP File is constructed on the output side and by running MCNP File the required Geometry shape is created.

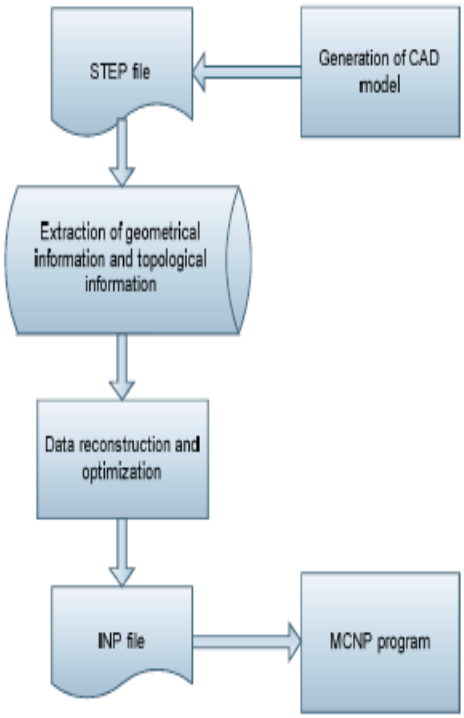


Figure 4.6: Conversion from STEP file to MCNP file flow chart

Chapter 5

SYSTEM IMPLEMENTATION

The finial stage is system implementation, that describes the algorithm and the flow chart designed and developed. With the help f this algorithm the code is developed in Python language.

5.1 Algorithm:

1. **Algorithm of Software Designed:**

   Step1: Constructing required geometry shape in CATIA Software and saving it in STEP file format (filename. stp).

   Step2: Now extracting required data from Step file for conversion is extracted using step code library.

   Step3: With the help of the conversion Algorithm the extracted data is converted and forms MCNP file using command: ./step2mcnp (filename. stp) (filename. mcnp)

   Step4: Finally MCNP file is run using ./mcnp i=filename ip.

2. **Algorithm for conversion of STEP file to MCNP file:**

   Step1:Start

   Step2:Read the input STEP-File and create intermediate representation along with the STEP Extractor.

   Step3:Store the generated intermediate representation in bucket i.e conversion bucket

   Step4:repeat: check again if there is any merge STEP-File

if yes , then repeat step2

else

fetch the Intermediate representation from the Conversion bucket.

Step5:Transform the STEP surfaces into MCNP surfaces and store into Converted Buckets.

Step6:For cell creation use the Edge cutting method and store into Converted Buckets.

Step7:Check: all the Intermediate representation is converted or not

if yes, create void cell

else

again fetch the Intermediate representation from the Conversion bucket and repeat transformation step.

Step8:Now Export MCNP-INP file from the Converted bucket and stop.

3. **Algorithm for Conversion with Edge Cutting Method:**

Step1:Start

Step2:check all the faces of the Solid Geometry and generate the cut-planes with the 3 points from its edges and connected edges.

Step3:Fetch the next face.

Step4:Is the face processed

if yes, fetch the next face

else

set face as processed and linked processed.

Step5:Create Sub-cell Boolean expression with face's signed surface number.

Step6:In sub-cell Boolean expression, intersect face with all the cut-planes.

Step7:Process its linked faces.

Step8:Check: Is all the face processed

if yes, then stop

else

again try to go to step3 to fetch next face and repeat the procedure.

4. **Algorithm for Conversion with Process its Linked faces Method:**

Step1:Start

Step2:Initialize the faces and master face of the solid geometry cut using Edge cutting method.

Step3: Fetch the next linked_face of the faces.

Step4: Check: is the linked_face processed or linked_processed

if yes, then go to step 3

else

check: is the signed surface number of linked_face to face or master same.

Step5:check: is the signed surface number of linked_face to face or master same

if yes, then check: is the face and master same

else

if yes, Set the linked_face as processed and goto step3

else

Check: is linked_face cutting face.

Step6: Check: is linked_face cutting face.

If yes, goto step3

else

Check : Each cut planes of face linked_face satisfy all vertices's in same sign.

Step7:Check : Each cut planes of face linked_face satisfy all vertices's in same sign.

If no, goto step3

else

check:for each cut_plane of linked_face, is face satisfied all vertices's in same sign.

Step8:check:for each cut_plane of linked_face, is face satisfied all vertices's in same sign

If no, goto step3

else

Set linked face as processed and linked_processed.

Step9:make expression with signed surface number

Step10: process linked_faces of linked_face

Step11:check: is all linked_face processed

if yes, then stop

else

goto step 3

The MCNP File also consist of the several different types of input file,but the main important and the default file we say is the INP file. The INP File consist of the all the input information that is necessary for describing the problems and also uses just the small part of the INP card just for solving one particular problem. The "card" defines the description of an input line that consist of 80characters at the maximum.

In the INP card the surface card and the cell card are generated from the CAD software. we had the file giving information on the Geometry and Topological, hence we have that the surface card consist of the information related to the Geometry and where else the cell card consist of the information that is related to the Topological in the STEP File. The main important thing is to verify that the entity or the shell is closed before the cell card gives out the information. Here one example is given for the description of the spherical model that is default closed with no judgment. Thus the given figure shows the information and the analysis of the sphere model. The figure is nothing but the extracted information from the STEP File of the Sphere that is constructed using the CATIA software.

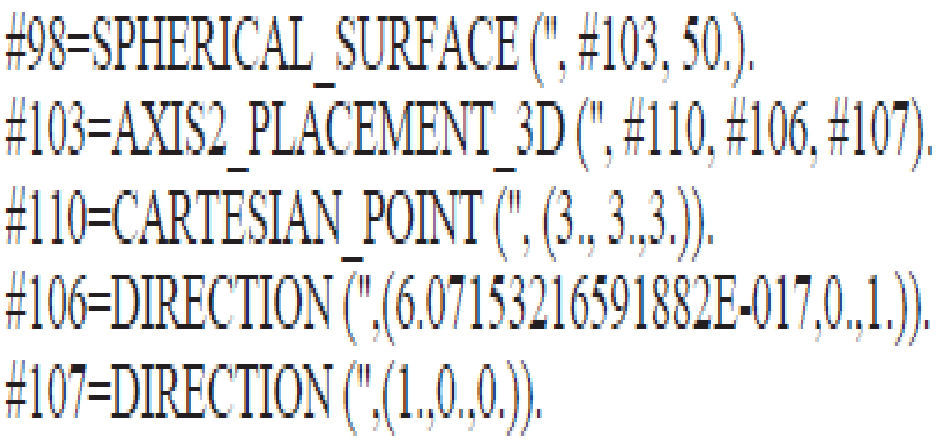
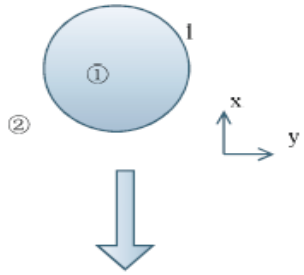


Figure 5.1: Extracted data from STEP File of Sphere

The SPHERICAL SURFACE is the type of the sphere surface who has every point equidistant from the center and that is also defined by the Radius, Location and the Direction. The figure explains that the # 98 is the ID number of sphere entity. Then

we have the # 103 that means the attributes that is inherited from the elementary surfaces,and namely has the position and orientation of the sphere.

The direction of the given axis is of the spherical in the direction of # 103 principal axis, i. e. (6.07153216591882E-017,0. ,1.). The sphere position is as the origin of the coordinate system of # 103,that is (1, 0, 0.). The radius is given to be 50. The corresponding file that is INP File can be the output after the above information is known. As known that the surface card information is corresponded to the geometry information, but the cell card information that is obtained from the sphere model is easier than the other model that is found. If suppose that the sphere inside the space then the entire space will be divided into the two cell by the sphere, the first cell is the inner side of the sphere and the second cell is the outer side of the sphere that is nothing but the rest of the world. The figure shows that the sphere is divided into the cell and the surfaces and also the INP File that is MCNP File is shown in the rectangle box.




```
C Surface Cards
1    so    50$Centered at the origin, a sphere of radius 50mm

C Cell Cards
1    -1
2     1
```

Figure 5.2: MCNP input file

5.2 Flow Chart:

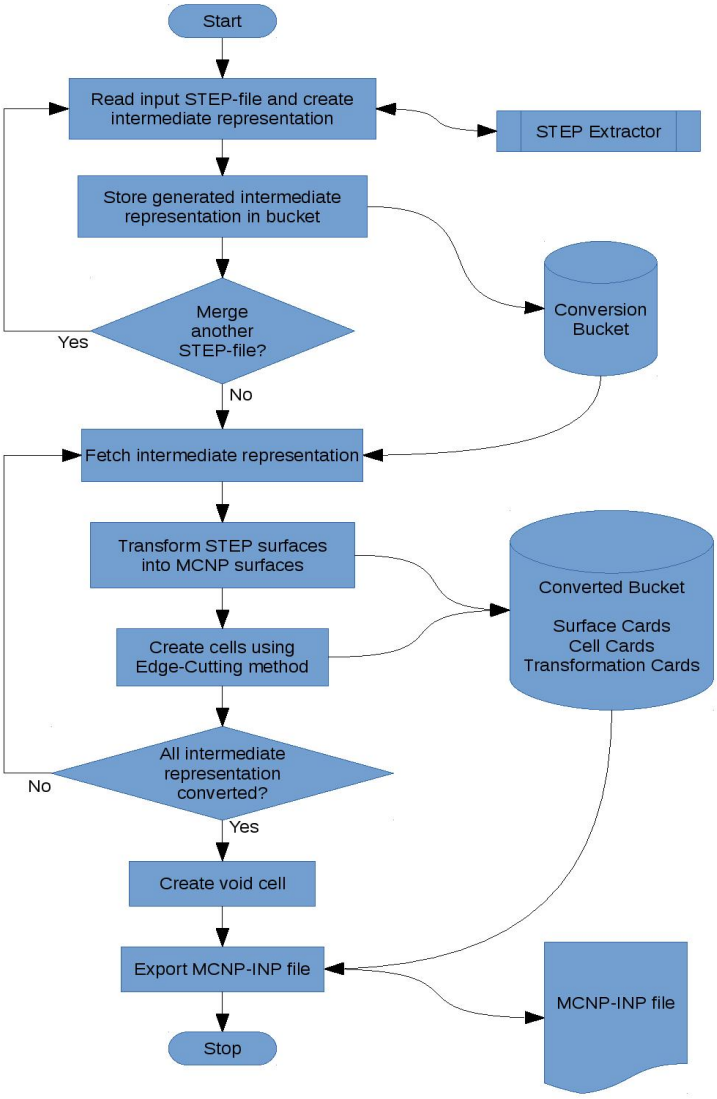


Figure 5.3: Flow Chart of conversion from STEP to MCNP

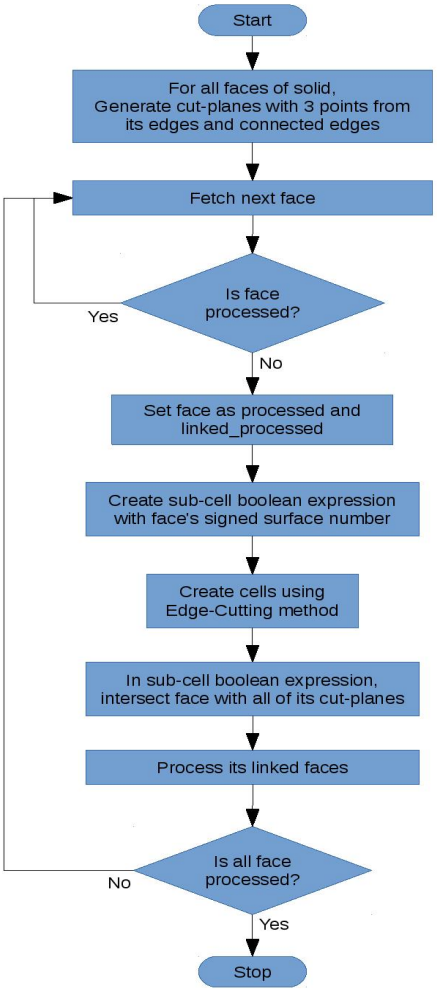


Figure 5.4: Flow Chart of conversion Edge Cutting from STEP to MCNP

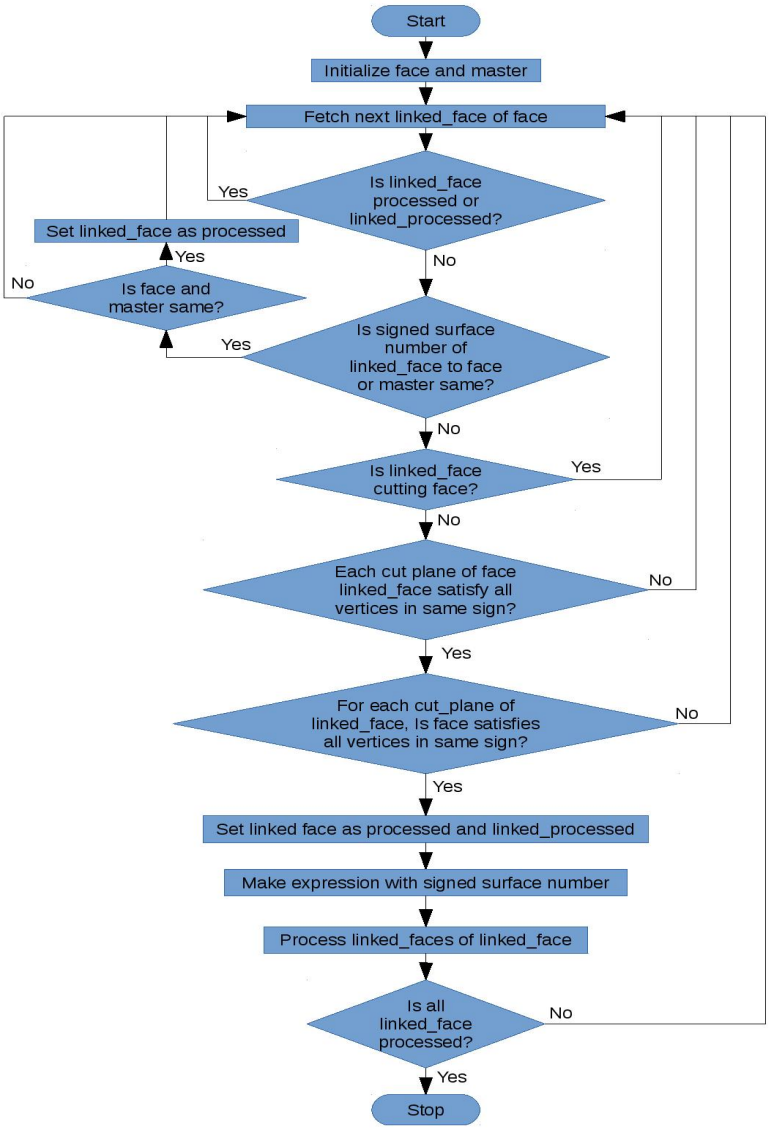


Figure 5.5: Flow Chart of conversion processing linked faces from STEP to MCNP

Chapter 6

EXPIREMENTS AND RESULTS

This chapter describes briefly about the Experiments and the Result of the experiments done. With the help of the algorithm that is developed all the different shapes were tested and successful outcome was generated. The first experiments were done on the five basic shapes known as Cube,Sphere,Cone,Cylinder and Torus.

The experiments where done like first the STEP File of all different shapes were taken by constructing them in the CATIA software. After constructing with the appropriate dimension in CATIA software those files had been saved in the .stp file that is nothing but STEP File. Then later the data is extracted from the step file using the algorithm of the conversion of STEP file to MCNP file discussed in the chapter5. Then the conversion algorithm discussed in chapter5, that is Edge cutting and Process Linked faces is applied and hence the output file is generated called INP File. This INP File is then run with the help of MCNP software and hence the output geometry is constructed.

Thus this way one by one required geometry model was examined and tested and hence the result had been successfully implemented. The table shown below are the tested geometry shapes and whose result are written in the table with the input file and output file. For Example the first table shows on the top left side the **FILENAME** where the STEP file name is written that is Plane.stp and similarly for different model different filenames will exist. Then comes the four important columns that is **MCNP origin,MCNP ex,STEP Volume(cc) and MCNP volume(cc)**.

Each of the columns explains some result, that is the **MCNP origin** explains the [X Y Z] coordinate system origin.**MCNP ex** explains the measurement.Then comes the informs the volume of the STEP File and similarly the **MCNP volume(cc)** informs the

volume of MCNP File.

The below columns shows the input geometry shape of the STEP File in XY,YZ,ZX directions and below that the output geometry shape of MCNP FIle in XY,YZ,ZX directions is shown. Thus if the correct output is obtained the conversion result is than written as successful or unsuccessful. Than at last row the information is given about the geometry dimensions.

The following tables shows the result of the different shapes that has been tested by the above procedure.

1. The outcome of the Cube geometry shape of MCNP origin (0,0,0) is shown in the table with the appropriate results and Cube is of dimension 25.4cm from all sides. Also the STEP File volume is 16387.06 and MCNP File Volume is 1.63871E+04. Hence the conversion result is Successful.

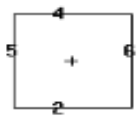
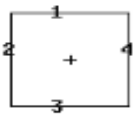
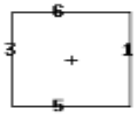
Filename	cube.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
12.5, 0, 0	100	16387.06	1.63871E+04
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : All sides of cube is 25.4 cm			

Table 6.1: Result of Simple Cube Structure

2. The outcome of the Cuboid geometry shape of MCNP origin (1.5,3,1.5) is shown in the table with the appropriate results and Cuboid is of dimension 30 x 60 x 30 cm. Also the STEP File volume is 54 and MCNP File Volume is 5.40000E+01.Hence the conversion result is Successful.

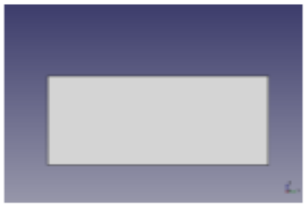
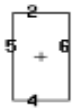
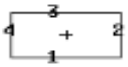
Filename	cuboid_1.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
1.5, 3, 1.5	25	54	5.40000E+01
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Dimension is 30 x 60 x 30 cm.			

Table 6.2: Result of Simple Cuboid Structure

3. The outcome of the Cuboid hole geometry shape of MCNP origin (2.5,3,1.5) is shown in the table with the appropriate results and Cuboid hole is of dimension 50 x 60 x 30 cm and 2.5 cm radius. Also the STEP File volume is 88.82 and MCNP File Volume is asymmetric. Hence the conversion result is Successful.

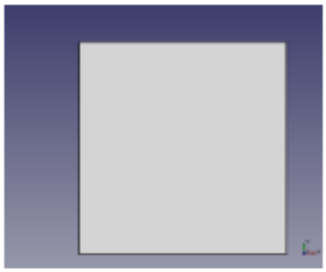
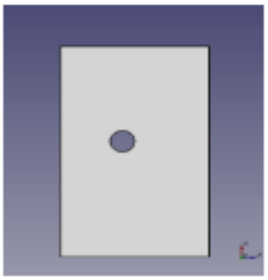
Filename	cuboid_hole.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
2.5, 3, 1.5	25	88.82	asymmetric
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Dimension is 50 x 60 x 30 cm with hole of radius 2.5 cm.			

Table 6.3: Result of Cuboid with hole inside Structure

4. The outcome of the Sphere geometry shape of MCNP origin (0,0,0)is shown in the table with the appropriate results and Sphere is of dimension with radius 10cm from all sides. Also the STEP File volume is 4188.74 and MCNP File Volume is 4.18879E+03. Hence the conversion result is Successful.

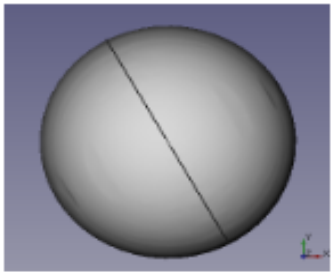
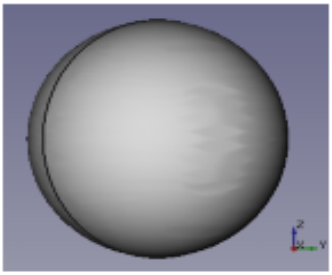
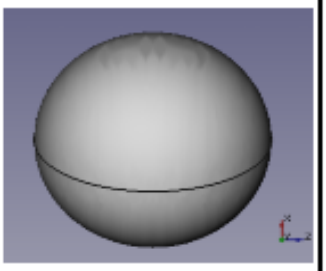
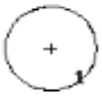
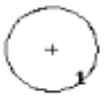
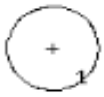
Filename	sphere_20.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, 0	100	4188.74	4.18879E+03
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Radius is 10 cm.			

Table 6.4: Result of Simple Sphere Structure

5. The outcome of the Hemisphere geometry shape of the MCNP origin(0,0,-0.5)is shown in the table with the appropriate results and hemisphere is of dimension with radius 1cm. Also the STEP File volume is 2.09and MCNP File Volume is 2.09440E+00. Hence the conversion result is Successful.

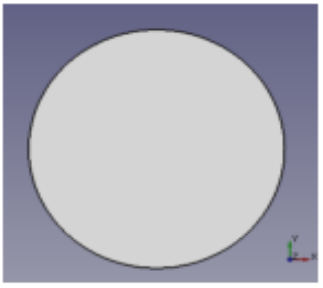
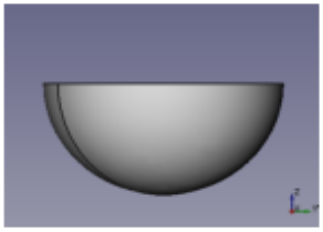
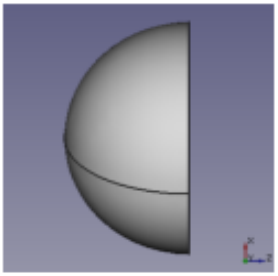
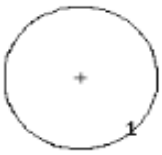
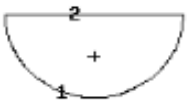
Filename	hemi-sphere_1.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, -0.5	5	2.09	2.09440E+00
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Radius is 1 cm.			

Table 6.5: Result of Hemisphere Structure

6. The outcome of the Cylinder geometry shape of the MCNP origin (0,0,5) is shown in the table with the appropriate results and hemisphere is of dimension with radius 1cm and height 10cm. Also the STEP File volume is 31.42 and MCNP File Volume is 3.14159E+01. Hence the conversion result is Successful.

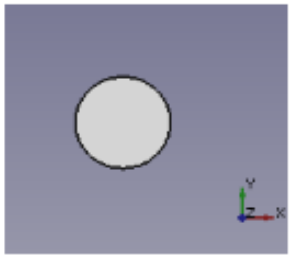
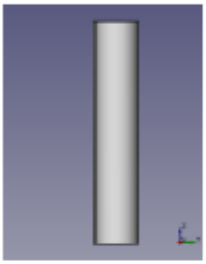
Filename	cyllinder_1.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, 5	50	31.42	3.14159E+01
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Radius is 1 cm and Height is 10 cm.			

Table 6.6: Result of Cylinder Structure

7. The outcome of the Cylinder hemisphere geometry shape of the MCNP origin (0,0,5) is shown in the table with the appropriate results and Sphere is of dimension with radius of 1cm and height of 10 cm along z-axis and hemisphere having radius of 1cm. Also the STEP File volume is 31.42(cylinder), 2.09(hemisphere) that is equal to 33.51 and MCNP File Volume is 3.14159E+01(cylinder), 2.09440E+00(hemisphere) is equal to 33.5103. Hence the conversion result is Successful.

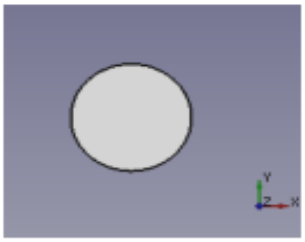
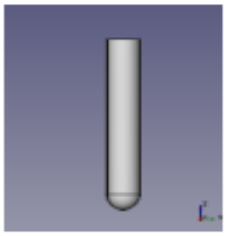
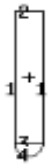
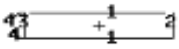
Filename	cyllinder_hemispher_1.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, 5	20	31.42 (cylinder), 2.09 (sphere) = 33.51	3.14159E+01 (cylinder), 2.09440E+00 (sphere) = 33.5103
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Cylinder having radius of 1 cm and height of 10 cm along z-axis. Hemisphere having radius of 1 cm.			

Table 6.7: Result of Cylinder with one hemisphere Structure

8. The outcome of the Cylinder hemisphere geometry shape of the MCNP origin (0,0,5) is shown in the table with the appropriate results and Sphere is of dimension with radius 1cm and height 10cm along z-axis and both hemisphere of 1cm. Also the STEP File volume is 31.42(cylinder), 2.09(hemisphere1), 2.09(hemisphere2) that is equal to 35.60 and MCNP File Volume is 3.14159E+01(cylinder), 2.09440E+00(hemisphere1), 2.09440E+00(hemisphere2) is equal to 35.6047. Hence the conversion result is Successful.

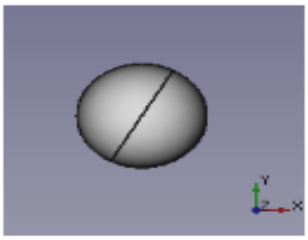
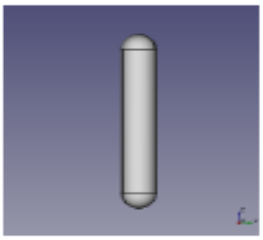
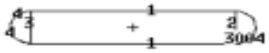
Filename	cyllinder_hemispher_2.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, 5	20	31.42 (cylinder), 2.09 (hemisphere 1), 2.09 (hemisphere 2) = 35.60	3.14159E+01 (cylinder), 2.09440E+00 (hemisphere 1), 2.09440E+00 (hemisphere 2) = 35.6047
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Cylinder having radius of 1 cm and height of 10 cm along z-axis. Both hemisphere having radius of 1 cm. In STEP, top hemisphere is nothing but replica of bottom hemisphere. In MCNP, it is shown by LIKE m BUT cell profile.			

Table 6.8: Result of Cylinder with two hemisphere Structure

9. The outcome of the Cylinder geometry shape of the MCNP origin (2.5,0,0) is shown in the table with the appropriate results and Cylinder is of dimension with radius 1.7cm and 2cm is radius of inner cylinder and outer cylinder. Also the STEP File volume is 17.44 and MCNP File Volume is 1.74358E+01. Hence the conversion result is Successful.

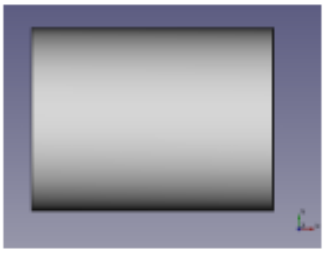
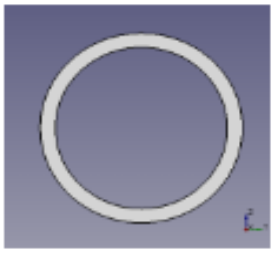
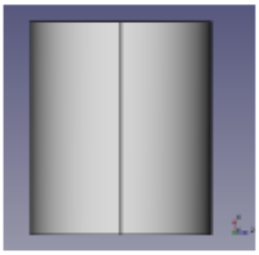
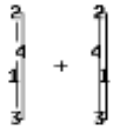
Filename	Part3.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
2.5, 0, 0	20	17.44	1.74358E+01
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : 1.7 cm and 2 cm is radius of inner cylinder and outer cylinder respectively with height of 5 cm.			

Table 6.9: Result of Simple Cylinder structure

10. The outcome of the Cone geometry shape with the MCNP origin (0,0,10)is shown in the table with the appropriate results and Cone is of dimension with base radius 8cm and height 20cm along z-axis. The volume of STEP File is 1340.41 and MCNP volume is 1.34041E+03. Hence the conversion result is Successful.

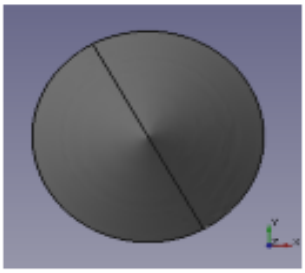
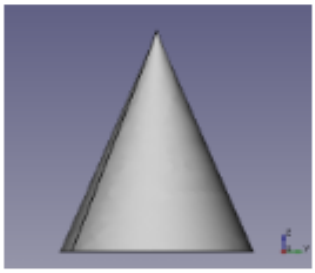
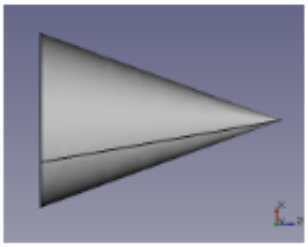
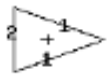
Filename	cone_1.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, 10	100	1340.41	1.34041E+03
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Cone having Base Radius of 8 cm and Height is 20 cm along z-axis.			

Table 6.10: Result of Cone Structure

11. The outcome of the Cut Cone geometry shape with the MCNP origin (0,0,5)is shown in the table with the appropriate results and Cone is of dimension with base radius 8cm and top radius is 4cm with height 10cm along z-axis. The volume of STEP File is 1172.89 and MCNP volume is 1.17286E+03. Hence the conversion result is Successful.

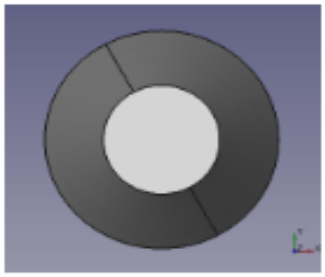
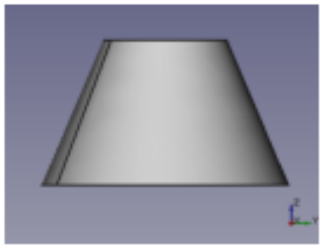
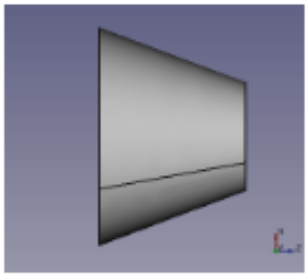
Filename	cone_cut_1.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, 5	100	1172.86	1.17286E+03
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Cone having Base Radius of 8 cm and Top Radius is 4 cm with Height 10 cm along z-axis.			

Table 6.11: Result of Cut Cone Structure

12. The outcome of the Torus geometry shape with the MCNP origin(0,0,0) is shown in the table the appropriate results and the dimensions with the major radius 7.5cm and minor radius 1cm. The STEP volume is 148.07 and MCNP volume is asymmetric. Hence the conversion result is Successful.

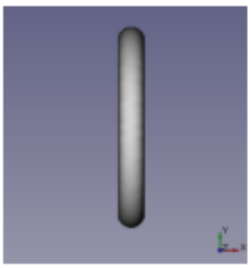
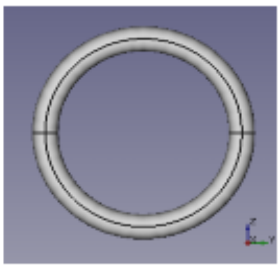
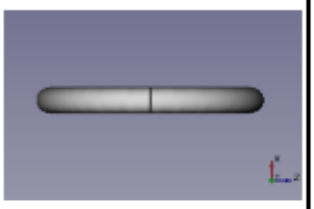
Filename	torus_1.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, 0	100	148.07	asymmetric
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Torus with major radius 7.5 cm and minor radius 1 cm.			

Table 6.12: Result of Torus Structure

13. The outcome of the Cut Torus geometry shape with the MCNP origin(0,0,0) is shown in the table the appropriate results and the dimensions with the major radius 7.5cm and minor radius 1cm and cut 1/4th part. The STEP volume is 111.03 and MCNP volume is asymmetric. Hence the conversion result is Successful.

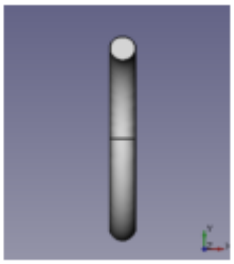
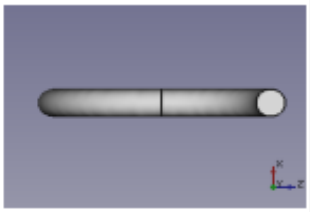
Filename	torus_cut_1.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, 0	100	111.03	asymmetric
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Torus with major radius 7.5 cm and minor radius 1 cm cutted 1/4th part.			

Table 6.13: Result of Cut Torus Structure

14. The outcome of the Cut Torus geometry shape with the MCNP origin(0,0,0) is shown in the table the appropriate results and the dimensions with the major radius 7.5cm and minor radius 1cm and cut 1/4th part. The STEP volume is 37.01and MCNP volume is asymmetric. Hence the conversion result is Successful.

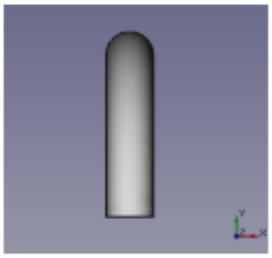
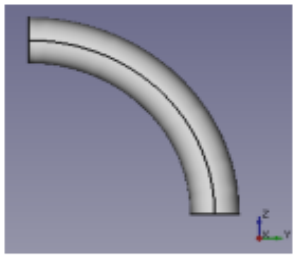
Filename	torus_cut_2.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, 0	50	37.01	asymmetric
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : Torus with major radius 7.5 cm and minor radius 1 cm cutted to 1/4th part.			

Table 6.14: Result of Cut Torus Structure

15. The outcome of the Four Cylinder hollowed geometry shape is shown with MCNP origin (0,0,50) and in the table with the appropriate results and Sphere is of dimension with: 4 concentric Cylinders, Inner Cylinder radius 1cm, 2nd outer Cylinder radius is 1.8cm, 3rd outer Cylinder radius is 2.3cm and 4th most outer Cylinder radius is 3.3cm. The STEP File volume is 314.16(1st), 703.72(2nd), 644.03(3rd), 1759.29(4th) is equal to 3421.19 and the MCNP volume is 3.14159E+02(1st), 7.03717E+02(2nd), 6.44026E+02(3rd), 175929E+03(4th) is equal to 3421.192. Hence the conversion result is Successful.

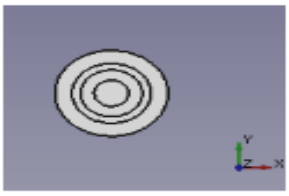
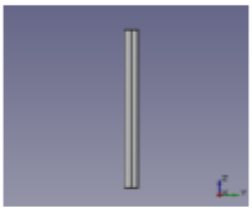
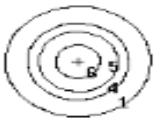
Filename	4cylinders_hollowed.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
0, 0, 50	100	314.16 (1 inner) 703.72 (2) 644.03 (3) 1759.29 (4 outer) = 3421.19	3.14159E+02 (1 inner) 7.03717E+02 (2) 6.44026E+02 (3) 1.75929E+03 (4 outer) = 3421.192
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note : 4 concentric cylinders, Inner cylinder radius is 1cm. 2nd outer cylinder radius is 1.8 cm. 3rd outer cylinder radius is 2.3 cm. 4th most outer cylinder radius is 3.3 cm.			

Table 6.15: Result of Four Cylinder Hollowed Structure

16. The outcome of the TF-Coil geometry shape with MCNP origin271,-254,0)is shown in the table with the appropriate results. The STEP volume is 15230159.52 and MCNP volume is asymmetric. Hence the conversion result is Successful.

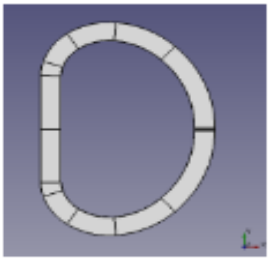
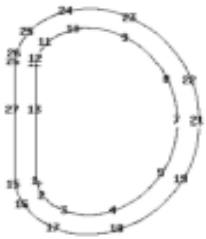
Filename	tf coil profile 4th in pro.stp		
MCNP origin	MCNP ex	STEP volume (cc)	MCNP volume (cc)
271, -254, 0	1000	15230159.52	asymmetric
STEP XY		STEP YZ	STEP ZX
			
MCNP XY		MCNP YZ	MCNP ZX
			
Conversion Result	Successful		
Note :			

Table 6.16: Result of TF-COIL Structure

Chapter 7

CONCLUSION AND FUTURE SCOPE

The Project concludes that an algorithm of conversion was put forward for conversion and software called CATIA for constructing all basic shapes and also few complex shape, the example of Sphere was explained in chapter System and Implementation with the spheres geometry and topology information output. where Sphere structure is build in the CATIA software and saved in form of STEP file. The resulting INP file can be used in MCNP successfully. The direction of the surface is an important and obscure factor when obtaining the topology information of the entities. All STEP files match the same criteria and similar way rest of different geometry is constructed. With these issues resolved, we will consider a number of complex shapes to convert, like the complex models which consist of basic entities through Boolean operations. And the Union, Intersection and Difference operation are the basis for complex models.

The contribution to the project work done by me is constructing the algorithm of conversion the main algorithm based on STEP File to MCNP File conversion, also other algorithm like Edge Cutting and Process Linked Faces. All this algorithm are studied carefully and coded in the Python language with different modules. The algorithm part is deeply explained in Chapter5 where System Implementation are mentioned and the coding part is partially explained in Chapter3 where System Specifications are mentioned. Also the MCNP generated file output is checked using MCNP software.

The contribution made by others is shapes construction that had been given by the CAD expertise according to the given dimensions and they even save it in form of STEP

file and thus they provide the reddy available STEP File on which further process done by me that is Python coding is applied. The result obtained is MCNP File conversion.

Future Scope will be developing more complex algorithm for complex structure and also solve error prone problems when the researchers handwritten MCNP input card.

References

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