AHMEDABAD UNIVERSITY | School of Engineering and Applied Science

SIMPLE PLANETARY GEARBOX MECHANISM

DYANAMICS OF MACHINE

Project Mentor

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LEARNING OBJECTIVES

- Learn how to Planetary gear trains works.
- Determine efficiency of gear trains.
- To transform motion by adapting velocity, torque and direction of movement.

INTRODUCTION

The planetary gear train is a core component of the automatic transmission system. The ability of the planetary gear train to deliver reliable gains in power, durability, higher torque-to-weight ratios, and configuration flexibility has enabled this gear set to become a key component of the automotive powertrain. A fundamental understanding of planetary gear trains is critical for individuals working in the automotive and industrial transmission fields.

Planetary gearboxes are more accurate and high precision due to their compactness. Planetary gearboxes have high efficiency and less power loss. Due to these features multi stage gearboxes are used for high power transmitting applications.

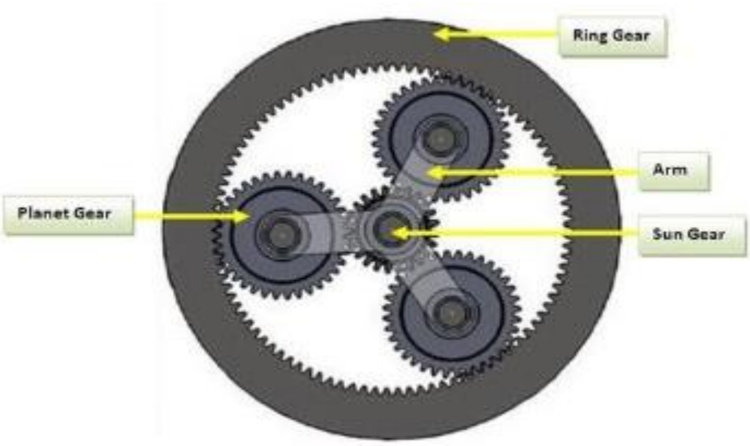


Figure above shows basic layout of planetary gear set which consists of four different elements that produce a wide range of speed ratios in compact layout. These elements are, (1) Sun gear, an externally toothed ring gear co-axial with the gear train (2) Annulus, an internally toothed ring gear coaxial with the gear train (3) Planets, externally toothed gears, which mesh with the sun and annulus, and (4) Planet Carrier, a support structure for planets, co-axial with the train. Planetary gear system as shown in Fig1 is typically used to perform speed reduction due to several advantages over conventional parallel shaft gear systems. Planetary gears are also used to obtain high power density, large reduction in small volume, pure torsional reactions and multiple shafting. Another advantage of the planetary gearbox arrangement is load distribution. The more the planets in the system, the greater load ability and the higher the torque density.

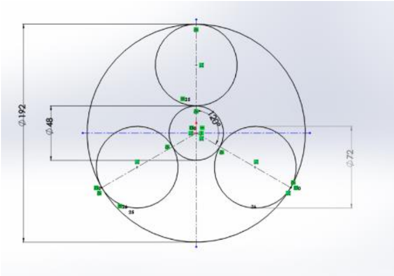
The PGT arrangement also creates greater stability due to the even distribution of mass and increased rotational stiffness. In today's scenario there is the need of lightweight and compact gearbox design with high load carrying capacity and compact in size.

LITERATURE SURVEY

An epicyclic gear train consists of two gears mounted so that the center of one gear revolves around the center of the other. A carrier connects the centers of the two gears and rotates to carry one gear, called the planet gear, around the other, called the *sun gear*. The planet and sun gears mesh so that their pitch circles roll without slip. A point on the pitch circle of the planet gear traces an epicycloid curve. In this simplified case, the sun gear is fixed and the planetary gear(s) roll around the sun gear.

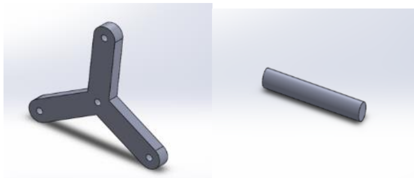
An epicyclic gear train can be assembled so the planet gear rolls on the inside of the pitch circle of a fixed, outer gear ring, or ring gear, sometimes called an annular gear. In this case, the curve traced by a point on the pitch circle of the planet is a hypocycloid.
The combination of epicycle gear trains with a planet engaging both a sun gear and a ring gear is called a planetary gear train. In this case, the ring gear is usually fixed and the sun gear is driven.

DESIGN

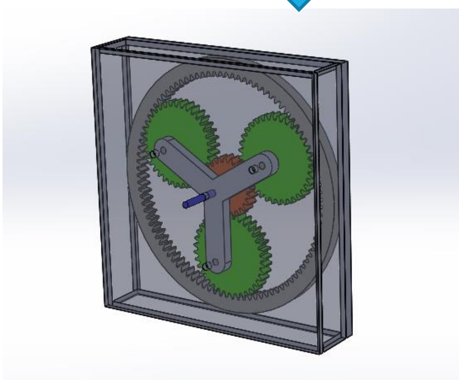


Sketch Layout

Gears



Carrier and Shaft



Final Design

DESIGN CALCULATION

Planetary spur gear drive ratio - 5:1

Number of teeths in sun gear - 24

Gear Module - 2

Means the sun gear must make 5 revolutions for each revolution of the output carrier.

Design requirements:
Ratio = 5:1
No of teeths of Sun gear = 24
Module = 2

All dimensions are in mm.

Here
M = Module
Ns = Number of teeth of sun gear
Nr = Number of teeth of ring gear ,

Np = Number of teeth of planet gear
PCD= Pitch Diameter
R = Ratio

$$\boldsymbol{PCD\ of\ sun\ gear} = \ number\ of\ teeths\ \times module = 24 \times 2 = 48\ mm$$

Calculating number of teeth required in Ring gear for the ratio **5:1**.

$$\boldsymbol{Ratio} = 1 + \frac{number\ of\ teeths\ of\ ring\ gear}{PCD\ of\ sun\ gear}$$

$$\boldsymbol{Number\ of\ teeths\ of\ ring\ gear} = PCD\ of\ sun\ Gear(R-1)$$

$$\boldsymbol{Number\ of\ teeths\ of\ ring\ gear} = 48(5-1) = 96$$

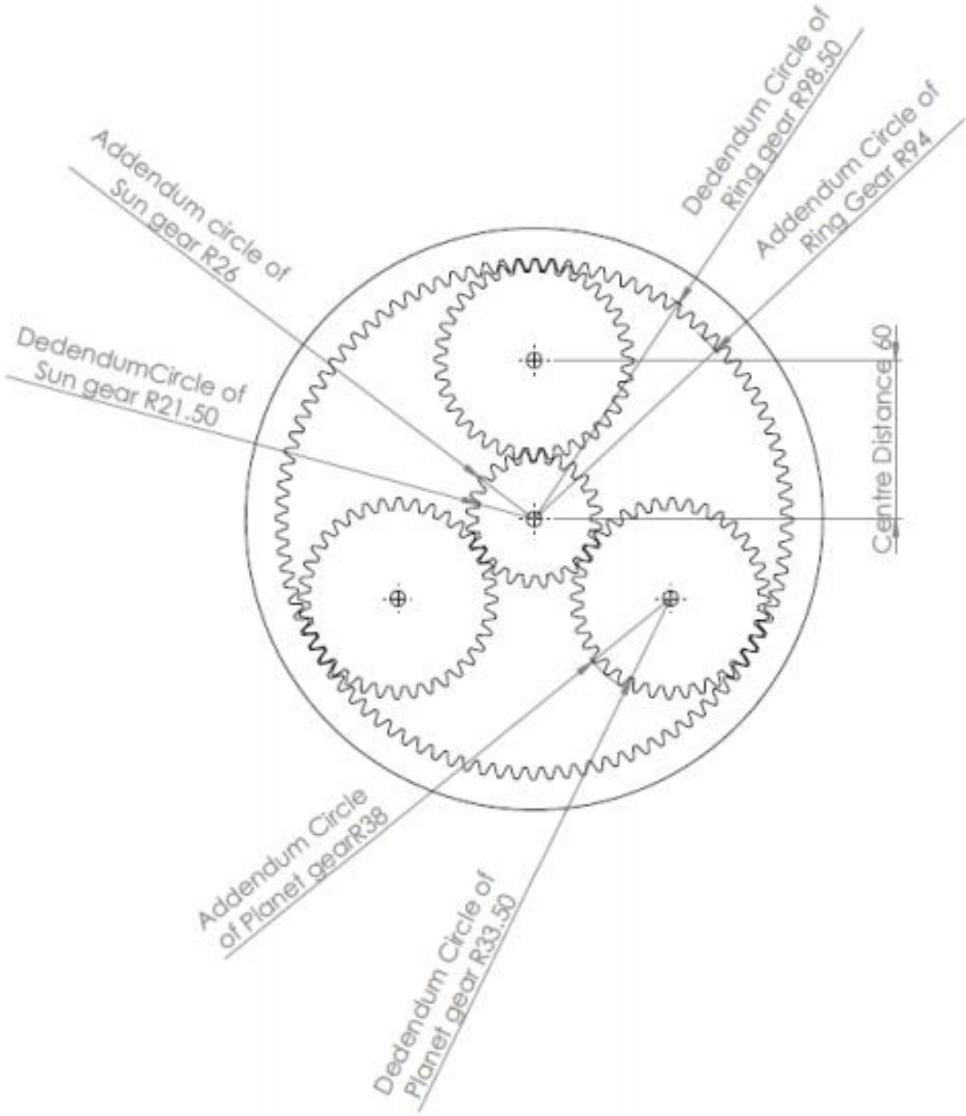
$$\boldsymbol{PCD\ of\ Ring\ Gear} = \ number\ of\ teeths\ \times module = 96 \times 2 = 192\ mm$$

$$\boldsymbol{PCD\ of\ Planet\ Gear} = 72\ mm$$

$$\boldsymbol{number\ of\ teeths\ of\ planet\ gear} = \frac{PCD}{module} = 36$$

Overall Dimension:

No	Description	Colour	Pitch circle diameter (mm)	Number of Teeth	Module
1	Sun Gear	Red	48	24	2
2	Planet Gears	Green	72	36	2
3	Ring Gear	Grey	192	96	2



Material Selection

We have selected four type of material for over project:

- MDF
- Acrylic
- Aluminium
- ABS

Analysis of individual material:

ALUMINIUM:

- Material cost is high
- Manufacturing cost

ACRYLIC

- Material cost is high
- Asthetic purpose
- Machinable limitation.

ABS

- Material cost is high
- Wearing resistance limitation
- Deformation due to heat

Finally, we have selected **MDF material**.

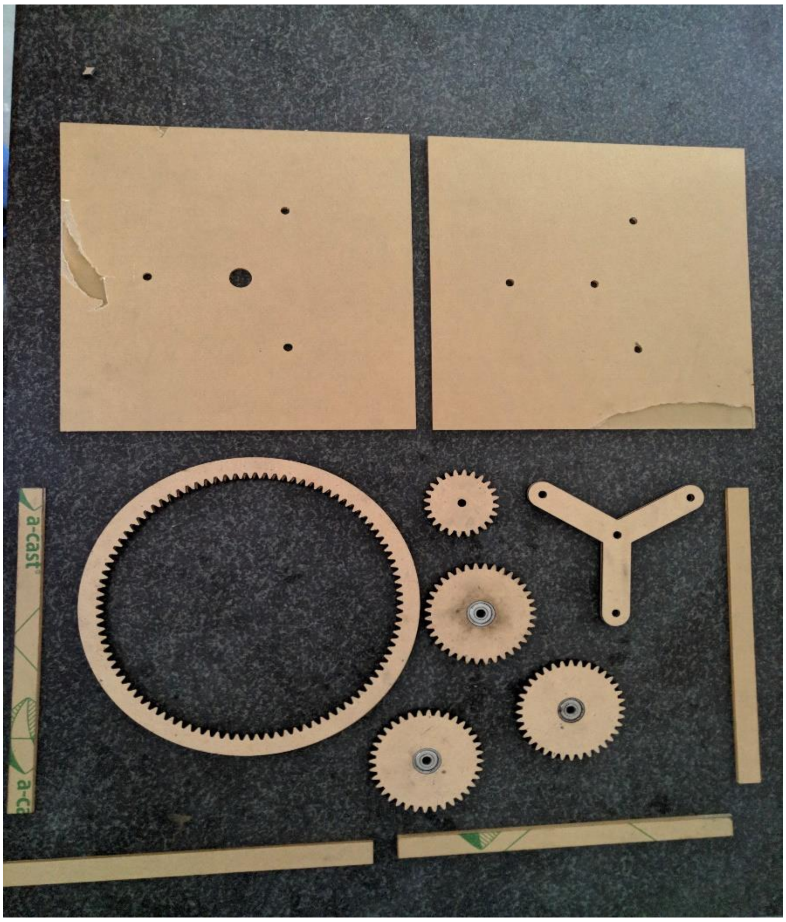
We choose **MDF material** due to ease of availability as per our diagram and low cost comparatively other chosen material machining is easy.

To give aesthetic look, we made outer case of acrylic material.

Manufacturing Methods

- Designing Simple planetary gear box, according to given formulas.
- Choosing appropriate gear train ratio.
- Finding number of teeth and pitch circle diameter of sun gear ring gear and planet gear.
- Making all the gears in CAD software.
- Converting all the gear files to DXF format.
- Cut the gears by using LASER CUT machine.
- Assemble all Parts & Testing.

PRE-ASSEMBLY MANUFACTURING COMPONENTS



FINAL DESIGN