Profile No.: 29 **NIC Code: 29301**

MANUFACTURING OF GEAR BOXES

1. INTRODUCTION:

Gears play a prominent role in mechanical power transmission. A gear or cogwheel is a rotating machine part having cut teeth, or cogs, which mesh with another toothed part to transmit torque.

Geared devices can change the speed, torque, and direction of a power source. Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine. The teeth on the two meshing gears all have the same shape. Two or more meshing gears, working in a sequence, are called a gear train.

Gears of various type, size and material are widely used in several machines and systems requiring positive and stepped drive.

2. PRODUCT & ITS APPLICATION:

A Gear train or Gear Box is a mechanical system formed by mounting gears on a frame so the teeth of the gears engage. Gear teeth are designed to ensure the pitch circles of engaging gears roll on each other without slipping, providing a smooth transmission of rotation from one gear to the next. The speed ratio for a pair of meshing gears can be computed from ratio of the radii of the pitch circles and the ratio of the number of teeth on each gear. Friction and wear between two gears is dependent on the tooth profile. The most commonly used in modern times, is the involute profile.

Features of gears and gear trains include:

- The ratio of the pitch circles of mating gears defines the speed ratio and the mechanical advantage of the gear set.

- A planetary gear train provides high gear reduction in a compact package.
- It is possible to design gear teeth for gears that are non-circular, yet still transmit torque smoothly.
- The speed ratios of chain and belt drives are computed in the same way as gear ratios.

There are several types of gears viz external gear with the teeth formed on the outer surface of a cylinder or cone and internal gear with the teeth on inner surface. Gears are generally specified by their type of tooth and blank shape e.g. spur, bevel, spiral etc., material, size or dimensions, geometry and special features, if any. The main types of gears can be classified as Spur, Helical, Worm Gears, and Bevel Gears etc.

- Spur gears have straight-cut tooth aligned parallel to the axis of rotation. Each teeth has involute profile these gears are used on parallel shafts and no axial thrust is created.

- Helical Gears are having tooth follow helix curve along the cylinder surface and therefore leading edges of the teeth are not parallel but at an angle to the axis of rotation. The angled teeth engage more gradually than do spur gear teeth, causing them to run more smoothly and quietly. The helical gears invariably produce axial thrust load. The helical profile can also be used to mesh with shafts axis oriented in various angles and these gears are called "skew helix gears".

- A bevel gear is shaped like a circular cone with most of its tip cut off. When two bevel gears mesh, their cone vertices are at the same point. Their shaft axes intersect at this point, forming an angle between the shafts. Spiral bevel gears are also manufactured as circular arc with non-constant tooth depth or circular arc with constant tooth depth. Spiral bevel gears have the same advantages and disadvantages relative to their straight-cut cousins as helical gears do to spur gears.

- A worm gear is when having large helix angle, close to 90 degrees and fairly long in the axial direction. I.e. forms screw like shape. Worms and worm wheel form a special gear type, where worm resemble screws and meshes with a worm wheel, which envelopes the worm screw. A worm-and- wheel set is compact way to achieve a high torque, low speed gear ratio.

- Special gears called sprockets are formed to engage with chains, viz bicycles and motorcycles. Even for belt drive pulleys with teeth are used in the timing belt drive, to synchronize the movement.

When gears are put in a frame or box, it is called Gear Box. There are several applications for witch, standard speed and power ratios are made available. The gear boxes have several purposes viz power/ torque amplifier or speed reducer where output gear has more teeth than the input gear. Conversely, if the output gear has fewer teeth than the input gear, then the gear train *reduces* the input torque and increases the speed of output shaft. All configurations and applications are possible for gears and gear box designs.

Gears are widely used in various mechanisms and devices to transmit power and motion positively without slip between parallel, intersecting axis and non-intersecting, non-parallel shafts, without change in the direction of rotation, with change in the direction of rotation, without change of speed of rotation, with change in speed at any desired ratio. Often some gearing system like rack – and – pinion is also used to transform rotary motion into linear motion and vice-versa.

The major applications are : Speed gear box, feed gear box and some other kinematic units of machine tools, Speed drives in textile, jute and similar machinery, Gear boxes of automobiles, Speed and / or feed drives of several metal forming machines, all most all industrial Machinery use gears and gear boxes. Large and heavy duty gear boxes are used in mining, cement industries, sugar industries, cranes, conveyors etc. Precision equipment like clocks and watches and industrial robots and toys also use gears.

3. DESIRED QUALIFICATIONS FOR PROMOTER:

Any ITI, Diploma or Graduate with some background in manufacturing or marketing.

4. MARKET POTENTIAL AND MARKETING ISSUES. IF ANY:

Gears and gear boxes are products mostly used in industrial machines and equipment and the gear products are out sourced by machinery manufacturers as they demand very specialized machinery for production of quality gears. Even the automobile gear trains are supplied by specialized manufacturing units.

In view of the rapid growth of industrial machinery and equipment sector, there is very good scope for a gear and gear box manufacturing unit with design, and manufacturing facilities and capabilities.

5. RAW MATERIAL REQUIREMENTS:

Various grades of alloy steels are most commonly used because of their high strength-to-weight ratio and low cost. These are either cast or forged depending on end application. Gear production is done by machining of standard stock items like rods, billets.

Numerous nonferrous alloys, cast irons, powder-metallurgy and even plastics are used in the manufacture of gears. The gear blanks are produced by die cast, investment casting, and powder metallurgy etc. processes.

The project may select product mix and select gear blank process viz casting / forging to focus the end consumer segments.

6. MANUFACTURING PROCESS:

Manufacture of gears needs several processing operations in depending upon the material and type of the gears and quality desired. The stages generally are:

- preforming the blank without or with teeth
- Annealing of the blank, if required, as in case of forged or cast steels
- Preparation of the gear blank to the required dimensions by machining

- producing teeth or finishing the preformed teeth by machining
- Full or surface hardening of the machined gear (teeth), if required
- Finishing teeth, if required, by shaving, grinding etc.
- Inspection of the finished gears.

Gear blanks and even gears along with teeth requiring substantial to little machining or finishing are produced by various casting processes.

- **Sand mold casting:** for large cast iron gears, low speed machinery and hand operated devices.

- **Shell mold casting:** Small gears in batches are often produced by this process.

- **Centrifugal casting:** The solid blanks or the outer rims (without teeth) of worm wheels made of cast iron, phosphor bronze or even steel are preferably performed by centrifugal casting. The performs are machined to form the gear blank of proper size. Then the teeth are developed by machining.

- **Metal mold casting:** Medium size steel gears with limited accuracy and finish are often made in single or few pieces by metal mold casting. For general and precision use the cast preforms are properly machined.

- **Die casting:** Large lot or mass production of small gears of low melting point alloys of Al, Zn, Cu, Mg etc. are done mainly by die casting. Such reasonably accurate gears are directly or after little further finishing are used under light load and moderate speeds, for example in instruments, camera, toys.

- **Investment casting**: This near-net-shape method is used for producing small to medium size gears of exotic materials with high accuracy and surface finish hardly requiring further finishing. These relatively costly gears are generally used under heavy loads and stresses.

It is estimated that almost 80% of all gearing produced worldwide is produced by using gear blanks cast, forged, in near final shape.

Machining:

The most common form of gear machining is cutting metal by tools called hob. The hobbing cutters rotate and mesh with gear blank like a meshing gear thereby generating teeth profile on blank. Other processes like gear shaping, milling, and broaching also exist. For metal gears in the transmissions of cars and trucks, the teeth are heat treated to make them hard and more wear resistant while leaving the core soft and tough. For large gears that are prone to warp, a quench press is used.

Finishing Processes:

Gear-tooth shaving, grinding, honing and lapping is the finishing processes that provide tooth profile correction, accurate tolerances and surface finish. Gear-honing machines produce teeth to reduce the surface roughness of the tooth profile. Gears are lapped on gear-lapping machines after they have undergone heat treatment.

Quality Control:

Overall gear geometry is inspected and verified using various methods such as coordinate-measuring machines, white light scanner or laser scanning. Metal composition is testes at blank stage. Other tests like teeth skin hardness etc. are done as per requirements.
Important dimensional variations of gears result from variations in the combinations of the dimensions of the tools used to manufacture them. An important parameter for meshing qualities is backlash. Precision gears are inspected by a method where meshing gear vibrations are recorded showing variations with a high resolution as the gear was rotated.

7. MANPOWER REQUIREMENT:

The unit shall require highly skilled service persons. The unit can start from 22 employees initially and increase to 47 or more depending on business volume.

Sr No	Type of Employees	Monthly Salary	No of Employees				
			Year 1	Year 2	Year 3	Year 4	Year 5
1	Skilled Operators	20000	8	12	16	18	20
2	Semi-Skilled/ Helpers	9000	10	12	14	16	18
3	Supervisor/ Manager	30000	1	2	2	3	3
4	Accounts/ Marketing	20000	1	2	3	4	4
5	Other Staff	8000	2	2	2	2	2
	TOTAL		22	30	37	43	47

8. IMPLEMENTATION SCHEDULE:

The unit can be implemented within 8 months from the serious initiation of project work.

Sr No	Activities	Time Required in Months
1	Acquisition of Premises	2
2	Construction (if Applicable)	2
3	Procurement and Installation of Plant and Machinery	3
4	Arrangement of Finance	2
5	Manpower Recruitment and start up	3
	Total Time Required (Some Activities run concurrently)	8

9. COST OF PROJECT:

The unit will require total project cost of Rs 319.23 lakhs as shown below:

Sr No	**Particulars**	**In Lakhs**
1	Land	25.00
2	Building	45.00
3	Plant and Machinery	177.00
4	Fixtures and Electrical Installation	4.85
5	*Other Assets/ Preliminary and Preoperative Expenses*	3.00
6	Margin for working Capital	64.38
	TOTAL PROJECT COST	319.23

10. MEANS OF FINANCE:

The project will require promoter to invest about Rs 128.09 lakhs and seek bank loans of Rs 191.14 lakhs based on 70% loan on fixed assets.

Sr No	Particulars	In Lakhs
1	Promoters Contribution	128.09
2	Loan Finance	191.14
	TOTAL:	319.23

11. WORKING CAPITAL REQUIREMENTS:

Working capital requirements are calculated as below:

Sr No	Particulars	Gross Amount	Margin %	Margin Amount	Bank Finance
1	Inventories	43.26	40	17.30	25.96
2	Receivables	50.41	50	25.20	25.20
3	Overheads	4.57	100	4.57	0.00
4	Creditors	43.26	40	17.30	25.96
	TOTAL	141.49		64.38	77.12

12. LIST OF MACHINERY REQUIRED:

Sr No	Particulars	UOM	Quantity	Rate	Total Value
	Main Machines/ Equipment				
1	Blank/ Billet cutting machines	Nos	2	150000	300000
2	Induction Heater for blanks	Nos	2	250000	500000
3	Pneumatic Forging Hammer	Nos	2	700000	1400000
4	Mech Forging Hammer	Nos	2	250000	500000
5	Gear Hobbing Machine	Nos	2	2000000	4000000
6	Gear Grinding Machine	Nos	2	1800000	3600000
7	Heavy Duty Milling Machine	Nos	2	550000	1100000

Sr No	Particulars	UOM	Quantity	Rate	Total Value
8	Heat Treatment Induction Type	Nos	2	180000	360000
9	Shot blasting machine	Nos	2	120000	240000
10	CNC Lathe	Nos	2	650000	1300000
11	Cylindrical Grinder	Nos	1	700000	700000
12	Lapping Machine	Nos	1	800000	800000
13	Lathe machine	Nos	2	200000	400000
14	Vertical Lathe	Nos	1	450000	450000
15	Radial & Pillar Drilling Machine	Nos	2	200000	400000
16	Gear Profile Inspection and Other Testing Machine	LS	3	100000	300000
17	5 axis Measuring m/c CNC	Nos	1	650000	650000
	Subtotal:				17000000
	Tools and Ancillaries				
1	Die tools and gauges	LS	1	500000	500000
2	Misc. tools etc.	LS	1	200000	200000
	Subtotal:				700000
	Fixtures and Elect Installation				
	Storage racks and trolleys	LS	1	75000	75000
	Other Furniture	LS	1	50000	50000
	Telephones/ Computer	LS	1	60000	60000
	Electrical Installation	LS	1	300000	300000
	Subtotal:				485000
	Other Assets/ Preliminary and Preoperative Expenses	LS	1	300000	300000
	TOTAL PLANT MACHINERY COST				**18485000**

13. PROFITABILITY CALCULATIONS:

Sr No	Particulars	UOM	Year Wise estimates				
			Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1	Capacity Utilization	%	25	35	45	55	65
2	Sales	Rs Lakhs	604.91	846.87	1088.83	1330.79	1572.75
3	Raw Materials & Other Direct Inputs	Rs Lakhs	519.11	726.76	934.41	1142.05	1349.70
4	Gross Margin	Rs Lakhs	85.79	120.11	154.42	188.74	223.06
5	Overheads Except Interest	Rs Lakhs	28.04	28.04	28.04	28.04	28.04
6	Interest	Rs Lakhs	26.76	26.76	26.76	26.76	26.76
7	Depreciation	Rs Lakhs	27.58	27.58	27.58	27.58	27.58
8	Net Profit Before Tax	Rs Lakhs	3.41	37.72	72.04	106.35	140.67

14. BREAK EVEN ANALYSIS:

The project is can reach break-even capacity at 24.01 % of the installed capacity as depicted here below:

Sr No	Particulars	UOM	Value
1	Sales at Full Capacity	Rs Lakhs	2419.62
2	Variable Costs	Rs Lakhs	2076.46
3	Fixed Cost incl. Interest	Rs Lakhs	82.39
4	Break Even Capacity	% of Inst Capacity	24.01