Applying Computer Programs to fill the gap between Metric and British standard systems of spur Gears

Salah aldeen A. Binhalim[1]
Yosif Ramadan[2]
Ali Abdullah Matos[3]

Abstract:

Globally, there are two standard units for gears, so it is difficult to exchange between them. The first is called the metric system, and the second is the British system. By choosing one of the types of computer programming Visual Basic is intended to fill the gap and difference to facilitate the exchange through the two systems in the program, such as (the number of teeth, center distance, stress, and standard) to easily change from the British system to the most common metric system. With a proposal for technical terms suitable for the type of gear instead of traditional and inappropriate technical terms.

[1]- Higher Institute of Engineering technology / khoms-Libya
[2]-Higher Institute/Tripoli-
[3]- Natural Sciences and Technology Research Authority / Tripole -Libya

Introduction:

Gears have been working since ancient times to transfer the movement from one movement shaft to another through the interlocking of the two gears. In calculating some of the components that go into completing the design of the gear, There is difficult to achieve because there are two different international standard systems in units, namely the metric system and the British system. [2]

Recently, there have been dramatic advances in procedures for computer aided design of mechanical system. In particular there have been significant advances infinite element analysis and in associated computer graphics procedures . Indeed finite element analysis and computer graphics have become standard procedures in mechanical design. [8 -9]

Nowadays , many gear standards societies , organization , associations , and/or institutes are present. Some of them are: the International standards organization(ISO)[7-11].the American Gear Manufacturers Association (AGMA). [12]

The American National standards Institute (ANSI) [13]. the American society of mechanical Engineers (ASME)[3].

Interchangeability of gears from different systems is still difficult. the main of this work is to fill gabs and improve Interchangeability between gears from different standardizing systems .

The components include the criterion, the number of teeth, the central distance between the gears, and, most importantly, the stress. Using one of the types of programming Visual Basic to

reduce and fill the gap and the difference between the two systems by setting correct values for the components of the British system to get through the program directly the values of the metric system. [11-12]

Recently, for gears, **THE TECHNICAL PARAMETER TERMINOLOGY** is known as pitch circle or base circle. It is recommended that technical terms be associated with the type of gear. For instance, regarding the type of the face gear in the interlock, the suitable term is a plane instead of a circle because the shape is a plane shape, not a circle shape, and regarding rack type gear, the term should be a line because the shape of the gear is line shape, not a circle shape. [10-14]

Governing Equations : [2]

1. $C_{in} = ((\frac{z_1}{pd})/2) + ((\frac{z_2}{pd})/2)$ Gear center Distance (in)
2. $C_{mm} = C_{in} * 25.4$ Gear center Distance (mm)
3. Md (module) = $\frac{25.4}{pd}$
4. $X = \frac{n1}{n2}$
5. $Y = (2 * C_{mm})$ / Md
6. $Pd = \frac{25.4}{\text{Md}}$ (in)
7. $rp = z_1 * 25.4/(2 * pd)$ (in)
8. $Ft = \frac{power}{w \times rp}$=(1000000) / (((2 x 3.14 x 1000) /(60)*rp) (in)
9. $Tp = (Ft * Pd)/(Y_1 * b)$ (in)
10. $rp = \frac{Md * z_1}{2}$ (mm)
11. $Ft = (1000000)/\left(\left(\frac{(2 \text{ x } 3.14 \text{ x } 1000)}{60} * rp\right)\right)$ (mm)
12. $Tp = (Ft)/Y_1 * b * Md)$ (mm)

Gear Parameters:

Gear identifying parameters as shown in table (1):

Table (1) lists most of gear design and values for a normal pressure angle degree.[2]

Term	**Metric**		**English**	
	Symbol	**Units**	**Symbol**	**Units**
Gear center Distance			C_{in}	in
Gear center Distance	C_{mm}	mm		
Diameteral pitch			pd	in
Number of Teeth First Mating Gear	n_1			
Number of Teeth Second Mating Gear	n_2			
Number of Teeth First Mating Gear			z_1	
Number of Teeth Second Mating Gear			z_2	
module	Md	mm		
gear ratio	X			
Face width	b	mm	b	in
The distance from the neutral axis of the gear tooth base cross section	Y			
Lewis factor	Y_1			
Pitch radius			rp	in
Tangent force	Ft			
bending stress	Tp			

- Preparation and steps for entering all data for the two global standard systems in the Visual Basic program

Public $n2, z1, z2$ As Integer

Public$cin, cmm, Pd, Md, X, b, Y, Y1, rp, Ft, Tp, Pdd$ As single:

On Error Go To aa:

$z1 = Val(Int(Text2.Text))$ 'Number of Teeth first Mating Gear

$z2 = Val\big(Int(Text1.Text)\big)$ 'Number of Teeth second Mating Gear

Text1.Text = z2

Text2.Text = z1

If (z1 > 4 And z2 > 4) Then

Pd = Val(Text7.Text) 'Diameteral Pitch

cin = ((z1 / Pd) / 2) + ((z2 / Pd) / 2) 'Gear Center Distance (in)

cmm = cin * 25.4 'Gear Center Distance (mm)

Md = 25.4 / Pd

X = 0.5

Y = (2 * cmm) / Md

n1 = (Y * X) / (1 + X)

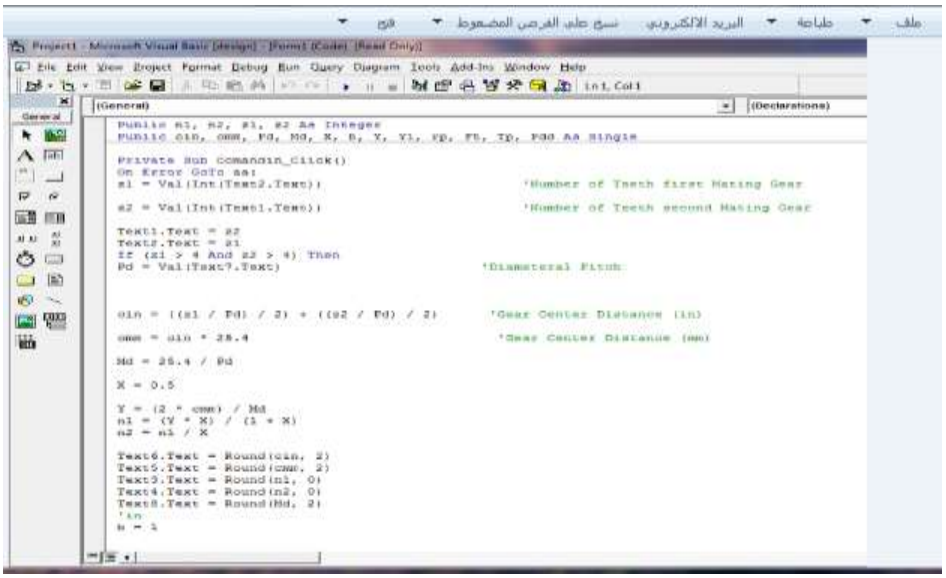
```
n2 = n1 / X
Text6.Text = Round(cin, 2)
Text5.Text = Round(cmm, 2)
Text3.Text = Round(n1, 0)
Text4.Text = Round(n2, 0)
Text8.Text = Round(Md, 2)
'in
b = 1
If (Option1 = True) Then
Y1 = 0.527
End If
If (Option2 = True) Then
Y1 = 0.577
End If
If (Option3 = True) Then
Y1 = 0.6
End If
If (Option4 = True) Then
Y1 = 0.583
End If
If (Option5 = True) Then
Y1 = 0.657
End If
If (Option6 = True) Then
Y1 = 0.693
End If
If (Option7 = True) Then
Y1 = 0.64
End If
If (Option8 = True) Then
Y1 = 0.673
End If
```

$$Pd= = \frac{25.4}{Md}$$

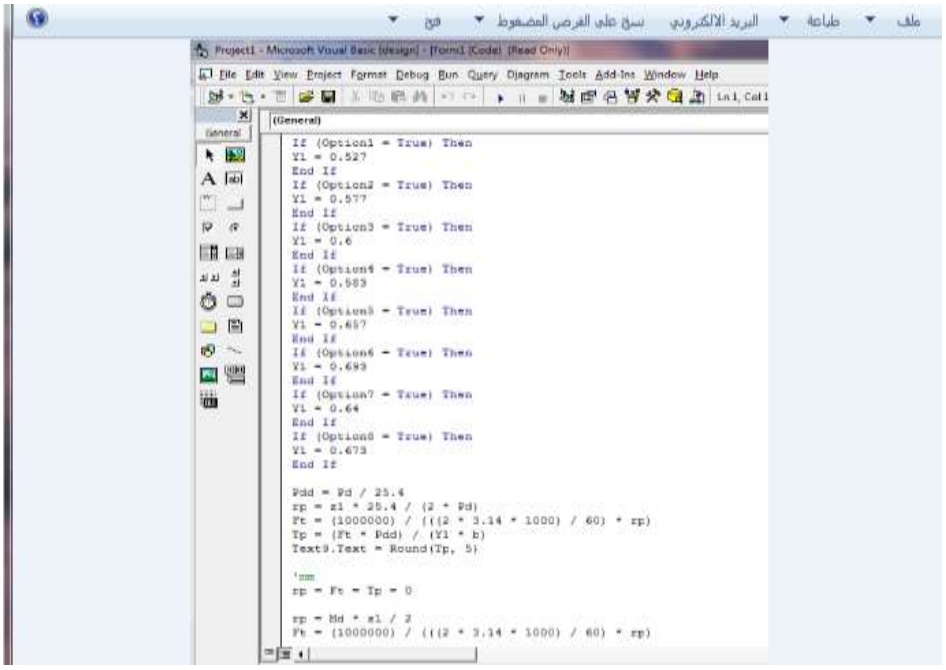
```
rp = z1 * 25.4 / (2 * Pd)
```

```
Ft = (1000000) / (((2 * 3.14 * 1000) / 60) * rp)
Tp = (Ft * Pdd) / (Y1 * b)
Text9.Text = Round(Tp, 5)
'mm
rp = Ft = Tp = 0
rp = Md * z1 / 2
Ft = (1000000) / (((2 * 3.14 * 1000) / 60) * rp)
Tp = (Ft) / (Y1 * b * Md)
Text12.Text = Round(Tp, 5)
Else
sad = MsgBox("íÌÈ Çä íßæä ÚÏÏ ÇáÇÓäÇä ÇßÈÑ ãä ÇÑÈÚÉ", , "
ãíßÇäíßÇ")
Text1.Text = ""
Text2.Text = ""
End If
Exit Sub
aa:
MsgBox Err.Description
End Sub
Private Sub Command1_Click()
Text1.Text = ""
Text2.Text = ""
Text3.Text = ""
Text4.Text = ""
Text5.Text = ""
Text6.Text = ""
Text7.Text = ""
Text8.Text = ""
Text9.Text = ""
Text12.Text = ""
End Su
```

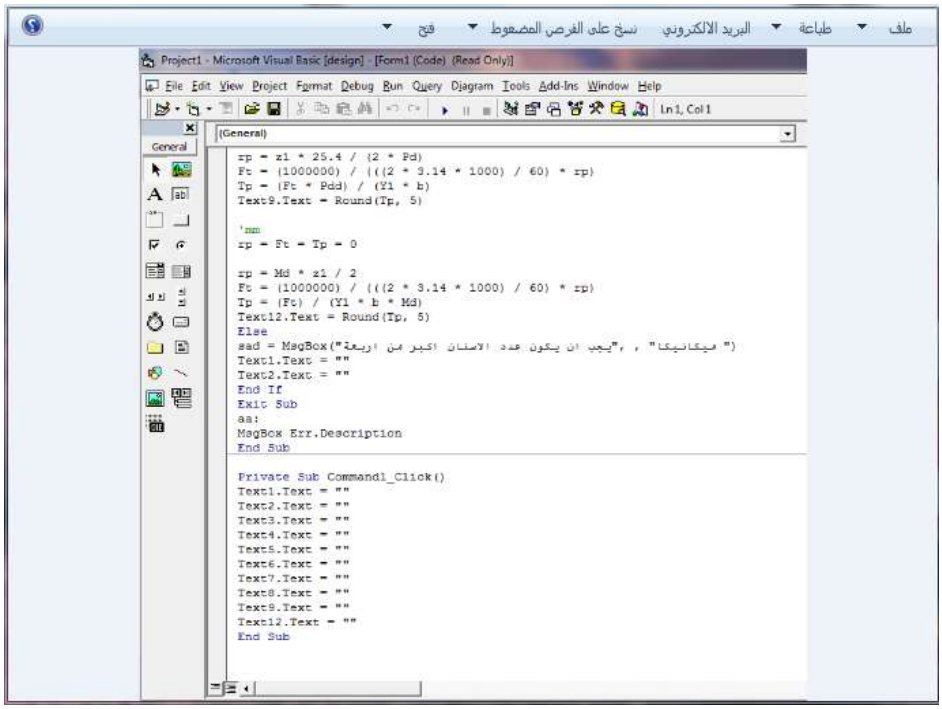
- Diagram shows the preparation steps to fill the gap between the two systems within the Visual Basic program and the final form obtained.

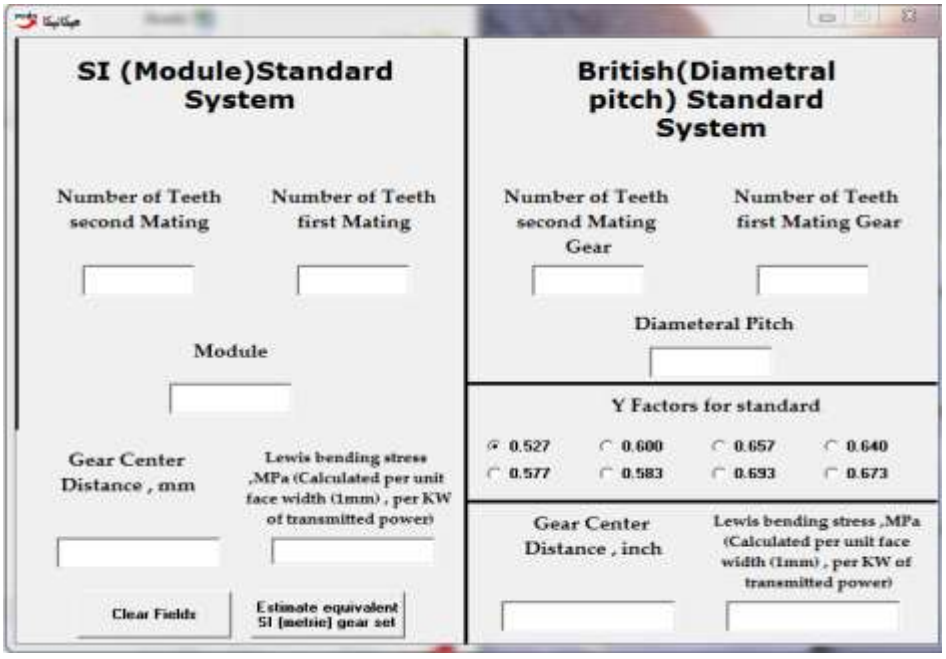


```
Public n1, n2, z1, z2 As Integer
Public oin, cmm, Pd, Md, X, Y, Y1, Fp, Ft, Tp, Pdd As Single

Private Sub Command1_Click()
On Error GoTo aa:
z1 = Val(Int(Text2.Text))                    'Number of Teeth first Mating Gear

z2 = Val(Int(Text1.Text))                    'Number of Teeth second Mating Gear

Text1.Text = z2
Text2.Text = z1
If (z1 > 4 And z2 > 4) Then
Pd = Val(Text7.Text)                      'Diametaral Pitch


oin = ((z1 / Pd) / 2) + ((z2 / Pd) / 2)      'Gear Center Distance (in)

cmm = oin * 25.4                             'Gear Center Distance (mm)

Md = 25.4 / Pd

X = 0.5

Y = (2 * cmm) / Md
n1 = (Y * X) / (1 + X)
n2 = n1 / X

Text6.Text = Round(oin, 2)
Text5.Text = Round(cmm, 2)
Text3.Text = Round(n1, 0)
Text4.Text = Round(n2, 0)
Text8.Text = Round(Md, 2)
'in
n = 1
```



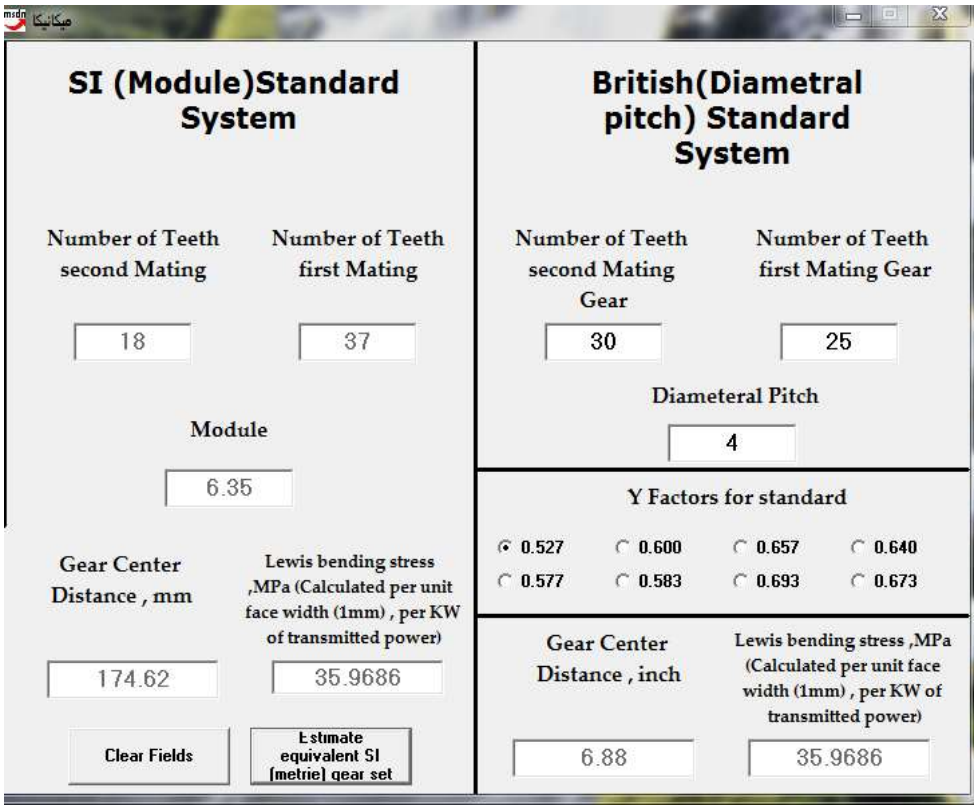
```
If (Option1 = True) Then
Y1 = 0.527
End If
If (Option2 = True) Then
Y1 = 0.577
End If
If (Option3 = True) Then
Y1 = 0.6
End If
If (Option4 = True) Then
Y1 = 0.589
End If
If (Option5 = True) Then
Y1 = 0.457
End If
If (Option6 = True) Then
Y1 = 0.693
End If
If (Option7 = True) Then
Y1 = 0.64
End If
If (Option8 = True) Then
Y1 = 0.673
End If

Pdd = Pd / 25.4
rp = z1 * 25.4 / (2 * Pd)
Ft = (1000000) / (((2 * 3.14 * 1000) / 60) * rp)
Tp = (Ft * Pdd) / (Y1 * b)
Text9.Text = Round(Tp, 5)

'mm
rp = Ft = Tp = 0

rp = Md * z1 / 2
Ft = (1000000) / (((2 * 3.14 * 1000) / 60) * rp)
```


ملف
طباعة
البريد الالكتروني
نسخ على القرص المضغوط
فتح
Project1 - Microsoft Visual Basic [design] - [Form1 (Code) (Read Only)]
File Edit View Project Format Debug Run Query Diagram Tools Add-Ins Window Help
Ln 1, Col 1
(General)
General
rp = z1 * 25.4 / (2 * Pd)
Ft = (1000000) / (((2 * 3.14 * 1000) / 60) * rp)
Tp = (Ft * Pdd) / (Y1 * b)
Text9.Text = Round(Tp, 5)
'mm
rp = Ft = Tp = 0
rp = Md * z1 / 2
Ft = (1000000) / (((2 * 3.14 * 1000) / 60) * rp)
Tp = (Ft) / (Y1 * b * Md)
Text12.Text = Round(Tp, 5)
Else
sad = MsgBox("يجب ان يكون عدد الاسنان اكبر من اربعة", , "ميكانيكا")
Text1.Text = ""
Text2.Text = ""
End If
Exit Sub
aa:
MsgBox Err.Description
End Sub
Private Sub Command1_Click()
Text1.Text = ""
Text2.Text = ""
Text3.Text = ""
Text4.Text = ""
Text5.Text = ""
Text6.Text = ""
Text7.Text = ""
Text8.Text = ""
Text9.Text = ""
Text12.Text = ""
End Sub


SI (Module)Standard System
Number of Teeth second Mating
Number of Teeth first Mating
Module
Gear Center Distance , mm
Lewis bending stress ,MPa (Calculated per unit face width (1mm) , per KW of transmitted power)
Clear Fields
Estimate equivalent SI [metric] gear set
British(Diametral pitch) Standard System
Number of Teeth second Mating Gear
Number of Teeth first Mating Gear
Diameteral Pitch
Y Factors for standard
0.527
0.600
0.657
0.640
0.577
0.583
0.693
0.673
Gear Center Distance , inch
Lewis bending stress ,MPa (Calculated per unit face width (1mm) , per KW of transmitted power)

Discussion and Conclusions:

1. In the Visual Basic program, an example was made in the number of teeth of the first and second, 25, 30, and the diameteral Pitch is 4, with choosing the value of Lewis Factor coefficient for the British system (by clicking on Clear Fields) we get (the number of teeth, the standard, the centre distance, the stress)directly in the metric system as shown the following diagram:



2. Although the gear standard systems are apparently two, they are basically the same in most aspects except the units. Therefore it is suggested to use a unified parameter to define either metric or English gears. the suggest that diametral pitch should be departed and replaced by the unified module. The unified module should be essentially expressed in units of millimeters (SI).

- ***Face gears*:** with face gears, classical definition of module has no meaning. Pitch circle is replaced by a mean circular pitch line. There is no addendum, or dedendum circles. Instead, there are outer and inner circles. Radial tooth width which is equal to (R_0 - R_i).
- ***Racks*:** racks are straight gears. The involute curve for a rack becomes a straight line because the base circle radius is infinity. For a rack, no circles are present. Pitch, base, addendum, and dedendum circles all are becoming straight lines. Table (2) and Figures (1) and (2) summarize this point.

Table (2) shows the differences between the inappropriate and suggested parameters

Gear Type	Inappropriate Parameter (Meaningless)	Equivalent Parameter	Suggested Standard Measuring Parameter
Face gear	**addendum circle**	**addendum plane**	**outermost circle**
	dedendum circle	dedendum plane	innermost circle
	pitch circle	pitch plane	mean circular pitch line
	base circle	base cylinder	
	face width	radial tooth width	radial tooth width
	circular pitch		angular pitch
	radial clearance	normal clearance	face clearance
Rack	addendum circle	addendum line	addendum line
	dedendum circle	dedendum line	dedendum line
	pitch circle	pitch line	pitch line
	base circle	base line	base line
	face width	rack width	rack width
	circular pitch	linear pitch	linear pitch

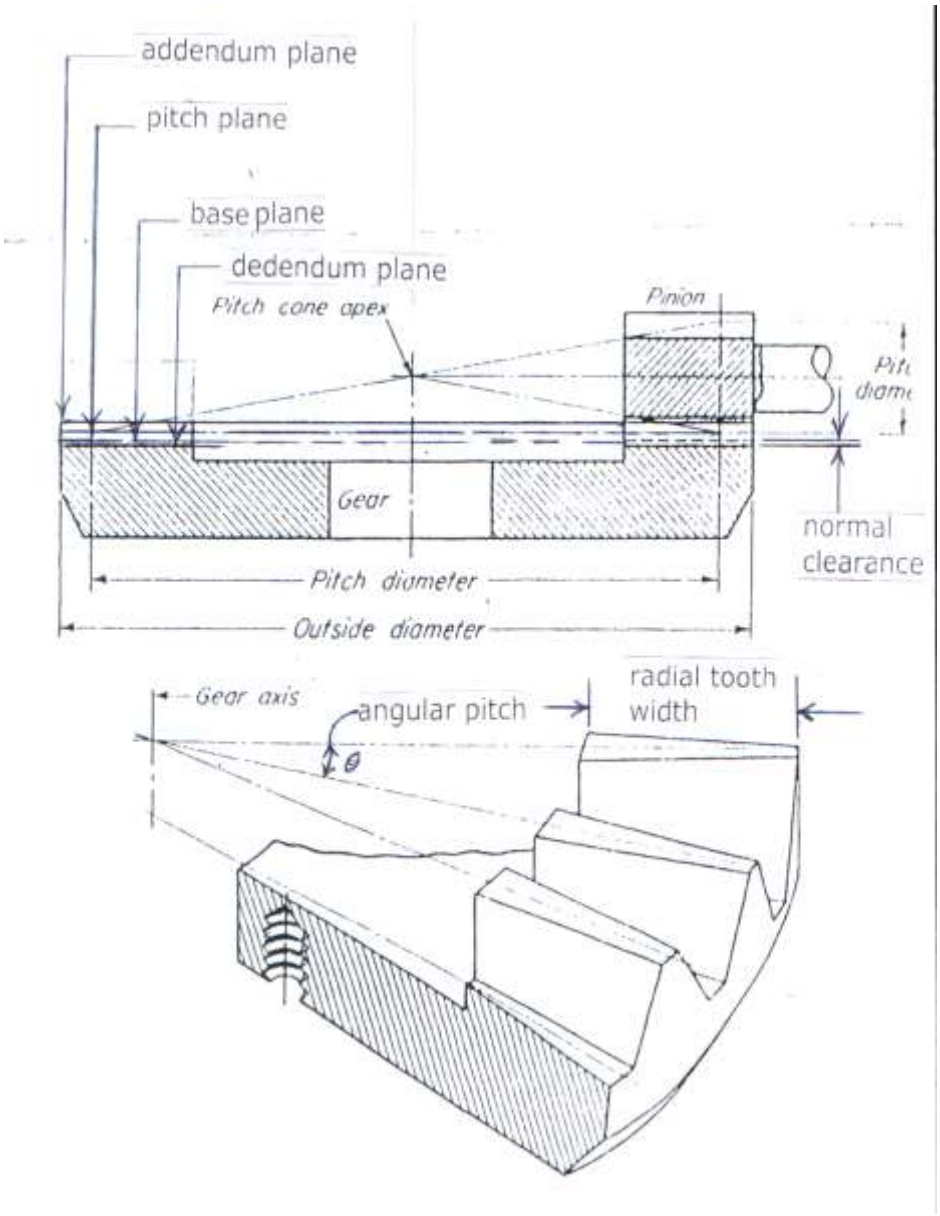


Fig.(1) Face Gear Corrected Terminology

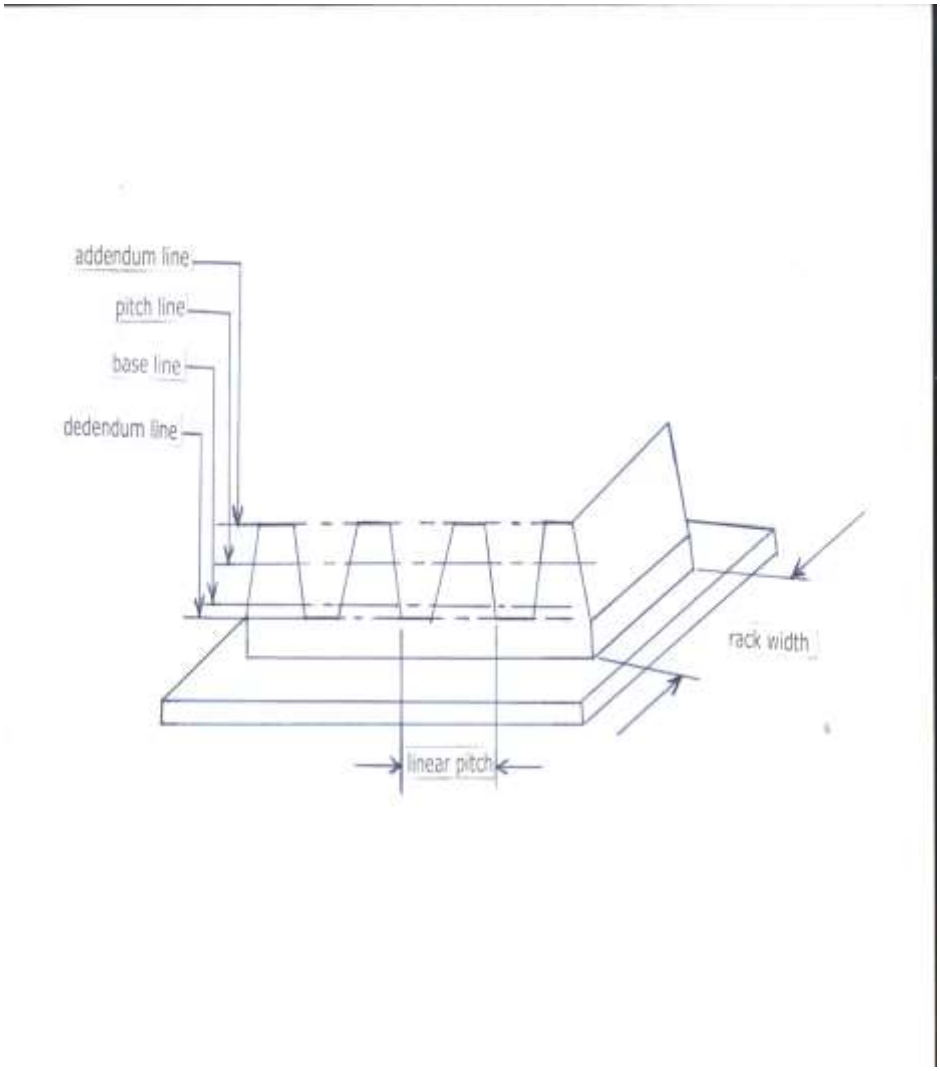


Fig (2) Rack Corrected Terminology

References

1. [1] Liu ,L.and Pinec , D. J. ,"The Influence of Gear Design Parameters on Gear Tooth Damage Detection Sensitivity, "ASME J.Mech.Des ,2002.
2. [2] Dudley,D.W., Handbook of Practical Gear Design, CRC Press, London, 1994.
3. Xu,H., Kahraman,A., Anderson,N.E., Maddock,D.G., "Prediction of MechanicalEfficiency of Parallel-Axis Gear Pairs," Transactions of the ASME, Vol. 129, , January 2007.
4. Kawalec , A.,and Wiktor , J.,"Analysis of Strength of Tooth Root With Notch After Finishing Of Involute Gears " Arch. Mech. Eng.2001
5. http://www.khkgears.co.jp/english.
6. http://www.admec.ntu.ac.uk.
7. ISO TC60 Business Plan 2005.
8. Höhn, Bernd-Robert, Welcome Address of the International Conference on Gears, Munich, Germany, September 14-16, 2005.
9. Lewicki, D. G., Handschuh , R . F., Spievak , L., E. Wawrzynek, P.A., and Ingraffea, A. R.,"Consideration of Moving Tooth Load in Gear Crack Propagation Predictions,"ASME,.Mech.Des., 2001.
10. Li, S., " Gear Contact Model and Loaded Tooth Contact Analysis Of a Three- Dimensional Thin- Rimmed Gear,".2002.
11. http://www.ISO.org.
12. http://www.AGMA.org.
13. http://www.ANSI.org.
14. Joseph Edward Shigley.R.Mischke" Mechanical Engineering Design", 1989.