Department of Mechanical Engineering
IIT, Kharagpur
Design of Machine Elements Practice (ME39602)
3rd. Design Assignment : Design of an Industrial General Purpose Reduction Gear Unit
(MONDAY Group : Spring Semester 2017)
[Duration (5 days) x 3 hours between –Mar 20 to Apr 17, 2017]

Design all gears and pinions of a two stage general purpose industrial gear box (see over leaf). Verify the design of the intermediate gear shaft with the helical & bevel - pinion & gear.

Select the bearings and draw plan, elevation and side views of the assembled gear sets placed in lower housing (see over leaf). Make a bill of material.

Data: The 2- stage reduction gear box has the following specifications. (Note: See illustrations overleaf as examples). In general non co-axial horizontal input and output (except otherwise mentioned).

GROUP	POWER (kW)	INPUT RPM	OUTPUT RPM	DUTY		OVERHAUL TIME	LUBRICATION
				Sub Group	Description		
I A, B, C, D,	12	1500	170	A,E,I,M, Q, U	Precision, Intermittent, No shock	2 years	Forced
II E, F,G,H	10	1800	200	B,F,J,N,R	General, Continuous, Medium shock		Oil Sump
III I, J, K, L	09	1450	125	C,G,K,O, S, V	General, Intermittent, Heavy Shock		Oil Sump
IV M,N,O,P	07	1200	125	D,H,L,P,T	Precision, Continuous, Medium Shock		Forced
V Q,R,S,T	05	1500	140				
VI U, V	06	950	100	Horizontal input and vertical output (Forced Lubrication)			

For helical gear (pinion) number of teeth may be taken as low as 15 & for straight bevel it is17.
(First stage reduction ratio to be around 3.)

Module (m, in meter) can be estimated as:

For helical gear: $m_{helical} = \sqrt[3]{\dfrac{2T\cos\beta}{\dfrac{S_d}{c_v c_w} ZY\psi}}$ For straight tooth bevel gear: $m_{bevel} = \sqrt[3]{\dfrac{2T}{\dfrac{S_d}{c_v c_w} ZY\psi(1-\psi_o)}}$

Where,

T = Torque (Nm), S_d = Allowable design strength (Pas),

Z = Number of teeth, β = Helix angle (degree),

c_v = Velocity factor, c_w = Wear load / Lubrication factor

(c_v = 1 for precision & 1.2 for general purpose gear)

c_w = 1 for force lubrication & 1.5 for sump/splash lubrication).

ψ = Width factor [active width (b) of gear/module],

$\psi_o = b/l$ for bevel gear (See Fig. -1), usually 1/3 or less,

Modified Lewis form factor $Y = \pi(0.154 - 0.912/Z')$:

For helical gear formative number of teeth, $Z' = Z/\cos^3\beta$;

and for straight bevel gear $Z' = Z/\cos\gamma$ (γ = pitch cone angle, see Fig.- 1).

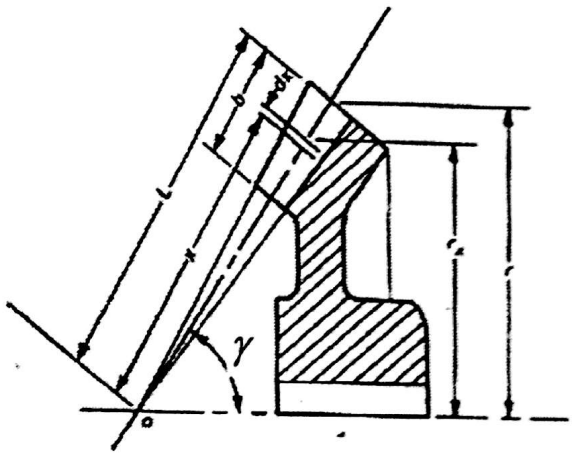

Fig.- 1: (Straight Bevel)

Pitch Circle Diameter, PCD (Helical) = $Z \times m_{helical} / \cos\beta$; Mean PCD (Straight Bevel) $= 2 \times mean\ r = Z \times m_{bevel}$.

$S_d = Yield\ strength/2.5\ to\ 3$. ***For selecting material and other information follow any machine design book.***

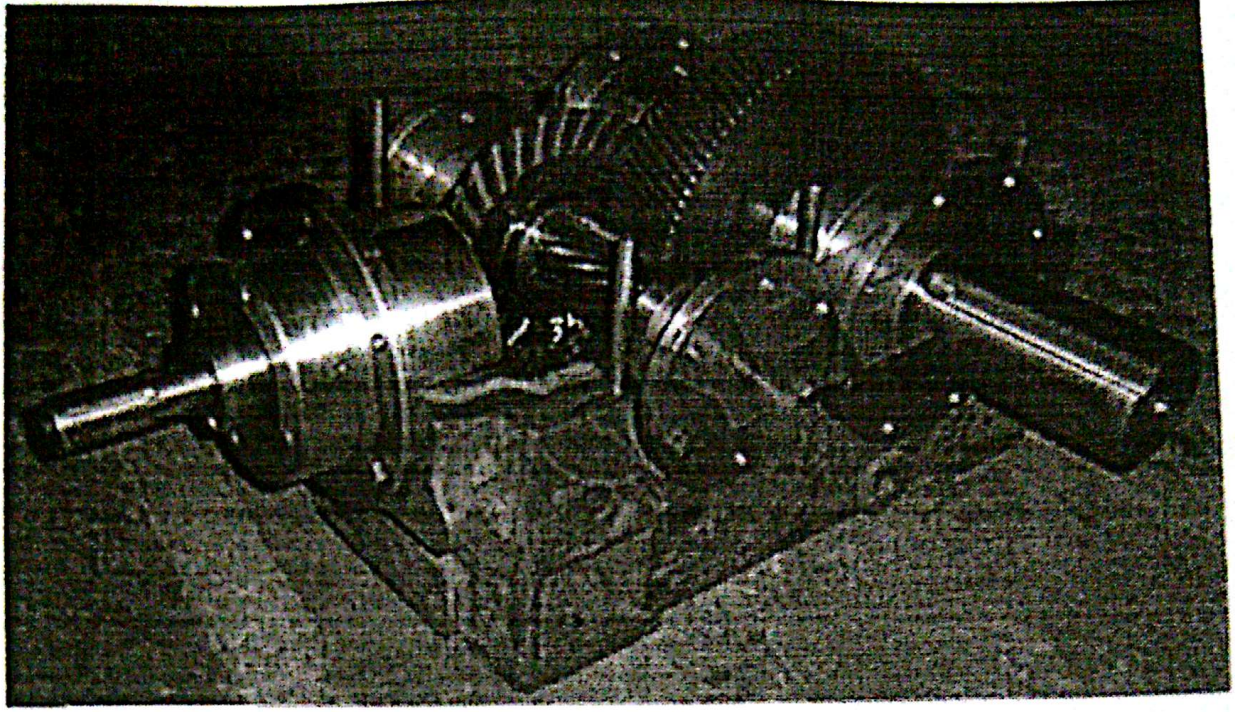

Fig.- 2: Photographic view (Example)
Two Stage Bevel-Helical Horizontal Input-Output.

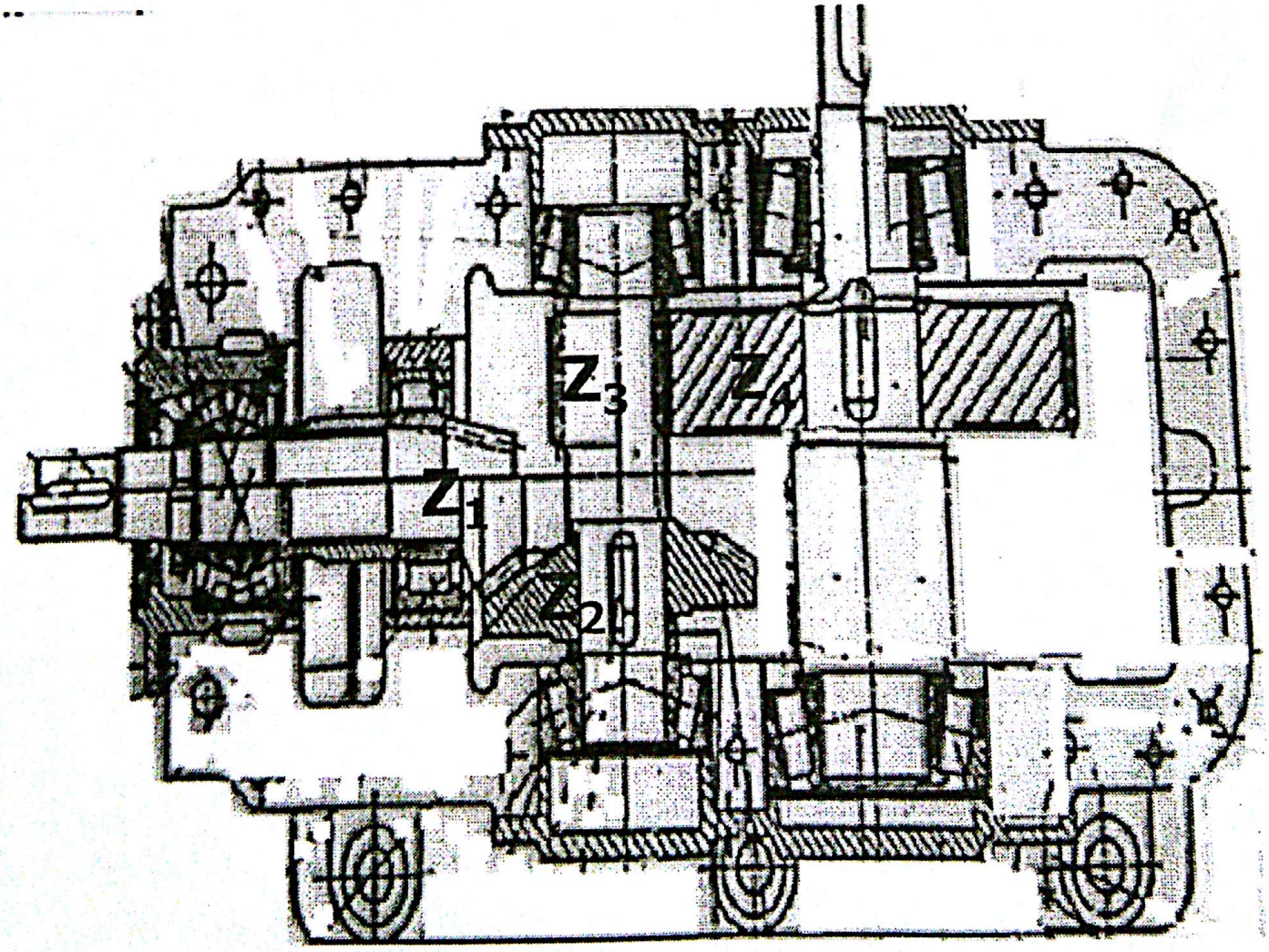

Fig.- 3: Assembled plan view (Top cover removed)
(Not of the same one as in Fig. 2).