Problem on Three Speed Gearbox

1) An automotive gear box gives three forward speeds and one reverse with a top gear of unity and bottom and reverse gear ratio of approximately 3.3:1. The center distance between the shaft is to be 110mm approximately. Gear teeth of module 3.25mm are to be employed.

Sketch the layout of a typical constant mesh gear box for these conditions giving the number of teeth for the various gear wheels and showing closely how the different ratios are obtained.

Given

$G_1 = 3.3:1 \Rightarrow 3.3$

$G_3 = 1:1 \Rightarrow 1$

$G_R = 3.3:1 \Rightarrow 3.3$

$l = 110\ mm$

$P = 3.25\ mm$

To design:

Three Speed Gearbox.

Solution

WKT,

$$T_A + T_B = T_C + T_D = T_E + T_f = \frac{l \times 2}{p}$$

$$= \frac{110 \times 2}{3.25}$$

$$T_A + T_B = T_C + T_D = T_E + T_F = 68$$

Since,

G_2 is not given so,

By using geometrical progression we can find Gear ratio "G_2".

$$G_2 = \sqrt{G_1 \times G_3} = \sqrt{1 \times 3.3}$$

$$\boxed{G_2 = 1.817}$$

Adopting the relation,

$$\frac{T_B}{T_A} = \frac{T_D}{T_C} = \sqrt{G_1}$$

$$\frac{T_B}{T_A} = \frac{T_D}{T_C} = \sqrt{3.3}$$

$$\boxed{\frac{T_B}{T_A} = \frac{T_D}{T_C} = 1.817}$$

$$\frac{T_B}{T_A} = 1.817$$

$$T_B = 1.817\, T_A$$

$$\frac{T_D}{T_C} = 1.817$$

$$T_D = 1.817\, T_C$$

$$T_A + T_B = 68$$

$$T_A + 1.817 T_A = 68$$

$$2.817\, T_A = 68$$

$$T_A = 24 \text{ teeth}$$

$$T_B = 1.817 \times 24$$

$$T_B = 44 \text{ teeth}$$

$$T_C + T_D = 68$$

$$T_C + 1.817\, T_C = 68$$

$$T_C = 24 \text{ teeth}$$

$$T_D = 1.817 \times 24$$

$$T_D = 44 \text{ teeth}$$

Actual $G_1 = \frac{T_B}{T_A} \times \frac{T_D}{T_C} = \frac{44}{24} \times \frac{44}{24}$

$$G_1 = 3.36 : 1$$

$$G_2 = \frac{T_B}{T_A} \times \frac{T_F}{T_E}$$

$$1.817 = \frac{44}{24} \times \frac{T_F}{T_E}$$

$$T_F = 0.99\, T_E$$

$$T_E + T_F = 68$$

$$T_E + 0.99\, T_E = 68$$

$$T_E = 34 \text{ teeth}$$

$$T_F = 34 \times 0.99$$

$$T_F = 34 \text{ teeth}$$

Actual $G_2 = \frac{T_B}{T_A} \times \frac{T_F}{T_E}$

$$= \frac{44}{24} \times \frac{34}{34}$$

$$G_2 = 1.835 : 1$$

$G_3 = 1:1 \rightarrow$ Top Gear

$G_R = 3.3$

$$G_R = \frac{T_B}{T_A} \times \frac{T_J}{T_I}$$

$$3.3 = \frac{44}{24} \times \frac{T_J}{T_I}$$

$$\frac{T_J}{T_I} = 1.8$$

$T_I + T_J < 68$

$$\frac{T_J}{22} = 1.8$$

T_I should be Small Gear wheel

So let us consider

$T_I = 22$ teeth

$\boxed{T_J = 40 \text{ teeth}}$

Actual

$$G_R = \frac{T_B}{T_A} \times \frac{T_J}{T_I} = \frac{44}{24} \times \frac{40}{22}$$

$\boxed{G_R = 3.33:1}$

Result:

$T_A = 24$ teeths

$T_B = 44$ teeths

$T_C = 24$ teeths

$T_D = 44$ teeths

$T_E = 34$ teeths

$T_F = 34$ teeths

$T_I = 22$ teeths

$T_J = 40$ teeths

Actual

$G_1 = 3.36:1$

$G_2 = 1.835:1$

$G_3 = 1:1$

$G_R = 3.3:1$