No.: ...... Date: ......

Bearing selection method.

(1) Roller bearing (no axial load)

- Use if no axial load present

Eq (11-3) - $C_{10} = F_D \left(\frac{L_D n_D 60}{L_R n_R 60}\right)^{3/10}$ if bearing reliability is 90%

compared to calculated C_{10}

- Find slightly larger C_{10} from table 11-3 to determine bearing size.

* F_D is determine from static analysis.

Eq (11-7) Use $C_{10} \doteq F_D \left[\frac{x_D}{0.02 + 4.439(1-R_D)^{1/1.483}}\right]^{3/10}$

if bearing reliability is more than 90%.

$$x_D = \frac{L_D n_D 60}{L_R n_R 60}$$

exponent = 10/3 for roller bearing

= 1/3 for ball bearing

Note that example 11-1 pg 555 is wrong

(2) Ball bearing without axial load.

The correct answer should be

$$C_{10} = F_D \left(\frac{L_D n_D 60}{L_R n_R 60}\right)^{1/3} = 2\left[\frac{5000(1725)60}{10^6}\right]^{1/3}$$

$C_{10} = 16.06$ kN (ball bearing)

Using Eq 11-7 with R = 0.90 should give same answer.

$$x_D = \frac{5000(1725)60}{10^6} = 517.5$$

$$C_{10} \doteq 2\left[\frac{517.5}{0.02 + 4.439(1-0.9)^{1/1.483}}\right]^{1/3} \Rightarrow C_{10} \doteq 16.28 \text{ kN}$$

Use table 11-2 : Ball bearing deep groove, bore = 30 mm

No.: .... Date: ....

(3) Ball bearing with axial load.

In this case we have both F_a and F_r

Refer to example 11-7 (b) page 569

For ball bearing selection with both F_a & F_r the trial and error process is outlined on page 569.

$V = 1$ if inner ring rotates

$V = 1.2$ if outer ring rotates.

$F_a = 1.531 kN$

$F_r = [1587^2 + 1324^2]^{1/2} = 2.067 kN$,

$R_D = 0.99$

Since ball bearing can take only radial load, and small axial load, the idea here is to find an equivalent radial load that will take into account both radial & axial loads. The formula is given as

$$F_e = X_i V F_r + Y_i F_a, \quad i = 1 \text{ when } \frac{F_a}{VF_r} \le e$$

(Eq 11-9)

$$i = 2 \text{ when } \frac{F_a}{VF_r} > e$$

X_1, Y_1 & X_2, Y_2 can be found in table 11-1

Solving part (b) of example 11-7

- To find F_e, we need X_1, Y_1 or X_2, Y_2, e and V

$V = 1$ since inner ring rotates.

e is unknown, assume $\frac{F_a}{VF_r} > e$, therefore

we need X_2, Y_2. Since e is unknown we have to guess X_2 & Y_2.

No.: .... Date: ....

Guess: $X_2 = 0.56$, $Y_2 = 1.63$ (middle entry of table 11-1)

$\rightarrow F_e = X_2 V F_r + Y_i F_a$

$= 0.56(2.067) + 1.63(1.531)$

$F_e = 3.653$ kN

$$C_{10} = a_f F_D \left[\frac{x_D}{x_0 + (\theta - x_0)(1-R_D)^{1/b}}\right]^{1/a} \quad ; R_D = 99$$

$$x_D = \frac{L_D n_D 60}{L_R n_R 60}$$

$x_0 = 0.02$; $(\theta - x_0) = 4.439$

$a = 3$ (ball bearing), $a = 10/3$ (roller bearing)

$b = 1.483$

$$C_{10} = 1.2(3.653)\left[\frac{393}{0.02 + 4.439(1-0.99)^{1/1.483}}\right]^{1/3} = 53.4 \text{ kN}$$

From table 11-2 angular contact bearing,

bore = 60 mm, $C_{10}' = 55.9$ kN, $C_0 = 35.5$ kN

Verify: $\frac{F_a}{C_0} = \frac{1.531}{35.5} = 0.0431 \rightarrow e \approx 0.24$

$\frac{F_a}{VF_R} = \frac{1.531}{1(2.067)} = 0.74 \therefore \frac{F_a}{VF_R} > e \rightarrow$ Find Y_2

F_a/C_0	Y_2
0.042	1.85
0.043	Y_2
0.056	1.71

Use interpolation

$$Y_2 = \frac{1.85-1.71}{0.042-0.056}(0.043-0.056)+1.71$$

$Y_2 = 1.84$

$F_e = 0.56(2.067) + 1.84(1.531) = 3.974$ kN

$C_{10} = 1.2(3.974)[\ \ldots\ ] = 57.3$ kN

$\rightarrow$ Bore = 65 mm, $C_{10} = 63.7$ kN, $C_0 = 41.5$ kN.

Guessed bore doesn't match verified bore diameter.

No.: .... Date: ....

Try again : $\frac{F_a}{C_0} = \frac{1.531}{41.5} = 0.0369 \rightarrow e \approx 0.23$

$\frac{F_a}{VF_r} = 0.74 > e = 0.23$

$\therefore$ Find Y_2

F_a/C_0	Y_2
0.028	1.99
0.0369	Y_2
0.042	1.85

$Y_2 = \frac{(1.99 - 1.85)}{(0.028 - 0.042)}(0.0369 - 0.042) + 1.85$

$Y_2 = 1.901$

$F_e = 0.56(2.067) + 1.901(1.531) = 4.068$

$C_{10} = 1.2(4.068)[\ldots] = 59.4\,kN$

From table $C_{10} = 63.7\,kN$, $C_0 = 41.5\,kN$

Bore = 65 mm

Because bore size is the same as before, iteration is complete.

Use 02-Series ball bearing bore = 65 mm