# Machine Design Test 3

July 25, 2022

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[1]:
```
# Notebook Preamble
import sympy as sp
import numpy as np
import matplotlib.pyplot as plt

plt.style.use('maroon_ipynb.mplstyle')
```

# Contents

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# 1 Problem 11-2

## 1.1 Given

A certain application requires a ball bearing with the inner ring rotating, with a design life of 25 kh at a speed of 350 rpm. The radial load is 2.5 kN and an application factor of 1.2 is appropriate. The reliability goal is 0.9.

## 1.2 Find

Find the multiple of rating life required, $x_D$, and the catalog rating $C_{10}$ with which to enter a bearing table. Choose a 02-series deep-groove ball bearing from Table 11–2, and estimate the reliability in use.

## 1.3 Solution

The relationship for $x_D$ is,

$$x_D = \frac{L_D}{L_R}$$

[2]:

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LD = 60*25_000*sp.S(350)
LR = 10**6
xD = LD/LR
xD
```

[2]:

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525
```

The catalog rating comes from Eq. 11-9,

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

[3]:

```
# Weibull parameters
x0, theta = sp.S('0.02'), sp.S('4.459')
b = sp.S('1.483')

a = sp.S(3)
af = sp.S('1.2')
FD = sp.S('2.5')
RD = sp.S('0.9')
C10 = af*FD*(xD/(x0 + (theta - x0)*(sp.log(1/RD))**(1/b)))**(1/a)
C10  # kN
```

[3]:

```
24.2553302533208
```

Choose the 02-35 mm with a $C_{10} = 25.5$ (from Table 11-2). The reliability may be estimated using Eq. 11-21.

$$R = \exp\left(-\left\{\frac{x_D\left(\frac{a_f F_D}{C_{10}}\right)^a - x_0}{\theta - x_0}\right\}^b\right)$$

[4]:

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C10 = sp.S('25.5')
R = sp.exp(-((xD*(af*FD/C10)**a - x0)/(theta - x0))**b)
R
```

[4]:

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0.919509230992636
```