```
clc;clear all;
```

Question 1

A 25 mm (02-series) deep-groove ball bearing carries a combined load of 2 kN radially and 3 kN axially at 1500 rpm. The outer ring rotates, and the load is steady. Determine the rating life in hours.

Table 11–2 Dimensions and Load Ratings for Single-Row 02-Series Deep-Groove and Angular-Contact Ball Bearings

Bore, mm	OD, mm	Width, mm	Fillet Radius, mm	Shoulder Diameter, mm		Load Ratings, kN			
						Deep Groove		Angular Contact	
				d_S	d_H	C_{10}	C_0	C_{10}	C_0
10	30	9	0.6	12.5	27	5.07	2.24	4.94	2.12
12	32	10	0.6	14.5	28	6.89	3.10	7.02	3.05
15	35	11	0.6	17.5	31	7.80	3.55	8.06	3.65
17	40	12	0.6	19.5	34	9.56	4.50	9.95	4.75
20	47	14	1.0	25	41	12.7	6.20	13.3	6.55
25	52	15	1.0	30	47	14.0	6.95	14.8	7.65

```
%% Solution
% _________
n = 1500;  %[rpm]
V = 1.2;  %[] outer ring rotation
F_a = 3;  %[kN]
F_r = 2;  %[kN]
a = 3;  %[] for ball bearings

% Using table 11-2
C = 14;     %[kN]  Dynamic load rating
C_s = 6.95;  %[kN]  Static load rating

% From table 10.6
F_a/C_s
```

```
ans = 0.4317
```

```
e = interp1([0.42, 0.56], [0.42, 0.44], F_a/C_s)
```

```
e = 0.4217
```

```
% To find X, Y from Table 10.6 we need to know if F_a / (V * F_r) > e
F_a / (V * F_r) > e
```

```
ans = logical
   1
```

```
X = 0.56;
Y = interp1([0.42, 0.44], [1.04, 1], e)
```

```
Y = 1.0367
```

```
% Calculate equivalent radial load
P = X * V * F_r + Y * F_a
```

```
P = 4.4540
```

```
% Calculate rating life
L_10 = 10^6/(60 * n) * (C / P)^a  %[hrs]
```

```
L_10 = 345.0547
```

Question 2

A 25 mm (02-series) for a single-row, angular-contact ball bearing having 35° contact angle carries a combined load of 2 kN radially and 3 kN axially at 1500 rpm. The outer ring rotates, and the load is steady. Determine the rating life in hours.

Table 11–2 Dimensions and Load Ratings for Single-Row 02-Series Deep-Groove and Angular-Contact Ball Bearings

Bore, mm	OD, mm	Width, mm	Fillet Radius, mm	Shoulder Diameter, mm		Load Ratings, kN			
						Deep Groove		Angular Contact	
				d_S	d_H	C_{10}	C_0	C_{10}	C_0
10	30	9	0.6	12.5	27	5.07	2.24	4.94	2.12
12	32	10	0.6	14.5	28	6.89	3.10	7.02	3.05
15	35	11	0.6	17.5	31	7.80	3.55	8.06	3.65
17	40	12	0.6	19.5	34	9.56	4.50	9.95	4.75
20	47	14	1.0	25	41	12.7	6.20	13.3	6.55
25	52	15	1.0	30	47	14.0	6.95	14.8	7.65

```
%% Solution
% ---------
n = 1500;  %[rpm]
V = 1.2;  %[] outer ring rotation
F_a = 3;  %[kN]
F_r = 2;  %[kN]
a = 3;  %[] for ball bearings

% Using Table 11-2
C = 14.8;  %[kN]  Dynamic load rating
C_s = 7.65;  %[kN]  Static load rating

% To find X, Y from Table 10.7 we need to know if F_a / (V * F_r) > e
e = 0.95;
F_a / (V * F_r) > e
```

```
ans = logical
   1
```

```
% From Table 10.7 we can therefore see that
X = 0.37;
Y = 0.66;
```

```
% Calculate equivalent radial load
P = X * V * F_r + Y * F_a
```

```
P = 2.8680
```

```
% Calculating rating life
L_10 = 10^6/(60 * n) * (C / P)^a  %[hrs]
```

```
L_10 = 1.5269e+03
```

Question 3

Determine the expected rating lives in hours of a 35 mm bore (02- and 03- series) straight cylindrical bearings operating at 2400 rpm. Radial load is 5 kN, with heavy shock, and the outer rings rotate. Calculate the expected rating life of the straight cylindrical bearing if only a 2% probability of failure can be permitted.

Table 11–3 Dimensions and Basic Load Ratings for Cylindrical Roller Bearings

	02-Series				03-Series			
Bore, mm	OD, mm	Width, mm	Load Rating, kN		OD, mm	Width, mm	Load Rating, kN	
			C_{10}	C_0			C_{10}	C_0
35	72	17	31.9	17.6	80	21	44.6	27.1

```
%% Solution
%----------
n = 2400;  %[rpm]
V = 1.2;  %[] outer ring rotation
F_a = 0;  %[kN]
F_r = 5;  %[kN]
a = 10/3;  %[] for roller bearings

% Using Table 11-3
C = 31.9;  %[kN]  Dynamic load rating
C_s = 17.6;  %[kN]  Static load rating
K_s = 1.7;  %[]  Shock factor from Table 10.8
X = 1;  %[] there is no axial load
Y = 0;  %[] there is no axial load

% Calculate equivalent radial load
P = K_s * V * F_r  %[kN]
```

```
P = 10.2000
```

```
% A reliability of 98% is required so that
K_r = 0.32;  %[]  Reliability factor from graph below

% Calculate L_2 life
L_2 = K_r * 10^6/(60 * n) * (C / P)^a  %[hrs]
```

```
L_2 = 99.4083
```

Question 4

Calculate the median lives in hours of a 75 mm bore 02 and 03-series straight cylindrical bearings operating at 2000rpm. Radial load is 25 kN, with light shock, and inner rings rotation

Table 11–3 Dimensions and Basic Load Ratings for Cylindrical Roller Bearings

	02-Series				03-Series			
Bore, mm	OD, mm	Width, mm	Load Rating, kN		OD, mm	Width, mm	Load Rating, kN	
			C_{10}	C_0			C_{10}	C_0
25	52	15	16.8	8.8	62	17	28.6	15.0
30	62	16	22.4	12.0	72	19	36.9	20.0
35	72	17	31.9	17.6	80	21	44.6	27.1
40	80	18	41.8	24.0	90	23	56.1	32.5
45	85	19	44.0	25.5	100	25	72.1	45.4
50	90	20	45.7	27.5	110	27	88.0	52.0
55	100	21	56.1	34.0	120	29	102	67.2
60	110	22	64.4	43.1	130	31	123	76.5
65	120	23	76.5	51.2	140	33	138	85.0
70	125	24	79.2	51.2	150	35	151	102
75	130	25	93.1	63.2	160	37	183	125

```
%% Solution
n = 2000;  %[rpm]
V = 1;  %[] inner ring rotation
F_a = 0;  %[kN]
F_r = 25;  %[kN]
a = 10/3;  %[] for roller bearings

K_s = 1;  %[]  Shock factor from Table 10.8
X = 1;  %[] there is no axial load
Y = 0;  %[] there is no axial load

% Calculating equivalent raidal load
P = K_s * V * F_r  %[kN]
```

```
P = 25
```

```
% Calculating median life (for 02 series)
C = 93.1;  %[kN]  Dynamic load rating
median_life_02_series = 5 * 10^6/(60 * n) * (C / P)^a  %[hrs]
```

```
median_life_02_series = 3.3354e+03
```

```
% Calculating rating median life (for 03 series)
C = 183;  %[kN]  Dynamic load rating
median_life_03_series = 5 * 10^6/(60 * n) * (C / P)^a  %[hrs]
```

```
median_life_03_series = 3.1732e+04
```

TABLE 10.5

Dimensions and Basic Load Ratings for Straight Cylindrical Bearings

	02-Series			03-Series		
Bore, D (mm)	OD, D_o (mm)	Width, w (mm)	Load Rating, C (kN)	OD, D_o (mm)	Width, w (mm)	Load Rating, C (kN)
25	52	15	16.8	62	17	28.6
30	62	16	22.4	72	19	36.9
35	72	17	31.9	80	21	44.6
40	80	18	41.8	90	23	56.1
45	85	19	44.0	100	25	72.1
50	90	20	45.7	110	27	88.0
55	100	21	56.1	120	29	102
60	110	22	64.4	130	31	123
65	120	23	76.5	140	33	138
70	125	24	79.2	150	35	151
75	130	25	91.3	160	37	183
80	140	26	106	170	39	190
85	150	28	119	180	41	212
90	160	30	142	190	43	242
95	170	32	165	200	45	264

TABLE 10.6

Factors for Deep-Groove Ball Bearings

		$F_a/VF_r \le e$		$F_a/VF_r > e$	
F_a/C_s	e	X	Y	X	Y
0.014[a]	0.19				2.30
0.21	0.21				2.15
0.028	0.22				1.99
0.042	0.24				1.85
0.056	0.26				1.71
0.070	0.27	1.0	0	0.56	1.63
0.084	0.28				1.55
0.110	0.30				1.45
0.17	0.34				1.31
0.28	0.38				1.15
0.42	0.42				1.04
0.56	0.44				1.00

Source: Based on Bamberger, E.N. et al., *Life Adjustment Factors for Ball and Roller Bearings: An Engineering Design Guide*, New York, ASME, 1971.

[a] Use 0.014 if $F_a/C_s < 0.014$.

TABLE 10.7

Factors for Commonly Used Angular-Contact Ball Bearings

			Single-Row Bearing		Double-Row Bearing			
			$F_a/VF_r > e$		$F_a/VF_r \le e$		$F_a/VF_r > e$	
Contact Angle (α)	e	$\frac{iF_a}{C_s}$ [a]	X	Y	X	Y	X	Y
	0.38	0.015		1.47		1.65		2.39
	0.40	0.029		1.40		1.57		2.28
	0.43	0.058		1.30		1.46		2.11
	0.46	0.087		1.23		1.38		2.00
15°	0.47	0.12	0.44	1.19	1.0	1.34	0.72	1.93
	0.50	0.17		1.12		1.26		1.82
	0.55	0.29		1.02		1.14		1.66
	0.56	0.44		1.00		1.12		1.63
	0.56	0.58		1.00		1.12		1.63
25°	0.68		0.41	0.87	1.0	0.92	0.67	1.41
35°	0.95		0.37	0.66	1.0	0.66	0.60	1.07

TABLE 10.8

Shock or Service Factors K_s

Type of Load	Ball Bearing	Roller Bearing
Constant or steady	1.0	1.0
Light shocks	1.5	1.0
Moderate shocks	2.0	1.3
Heavy shocks	2.5	1.7
Extreme shocks	3.0	2.0