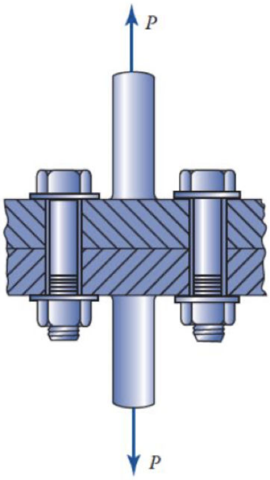
Question 1

A bolted joint with two class number 4.8 steel bolts is to support an external load of P = 11.6 kN, and the stiffness constant ration is to be $k_p/k_b = 3$, determine

- The required bolt preload

- The thread size of the bolt



Metric Specifications and Strengths for Steel Bolts

Class Number	Size Range Diameter, d (mm)	Proof Strength, S_p (MPa)	Yield Strength, S_y (MPa)	Tensile Strength, S_u (MPa)	Material Carbon Content
4.6	M5–M36	225	240	400	Low or medium
4.8	M1.6–M16	310	340	420	Low or medium

Solution

Each bolt supports half the load

```
P = 11.6e6/2 %[N]
```

```
P = 5800000
```

Bolt axial force

$$F_b = C \cdot P + F_i = \left(\frac{k_b}{3k_b + k_b}\right)5.8 \times 10^6 + F_i = \frac{1}{4} \cdot 5.8 \times 10^6 + F_i = 1.45 \times 10^6 + F_i$$

Clamping force

$$F_p = (1 - C)P - F_i = \left(1 - \frac{k_b}{3k_b + k_b}\right)P - F_i = \frac{3}{4} \cdot 5.8 \times 10^6 - F_i = 4.35 \times 10^6 - F_i$$

Joints separate when $F_p = 0$

```
F_i = 4.35e6
```

```
F_i = 4350000
```

```
F_b = 1.45e6 + F_i
```

```
F_b = 5800000
```

From the table above (Ugeral, 15.4) $S_p = \frac{F_b}{A_t} = 310 \times 10^6$

```
A_t = F_b / 310e6 %[m^2]
```

```
A_t = 0.0187
```

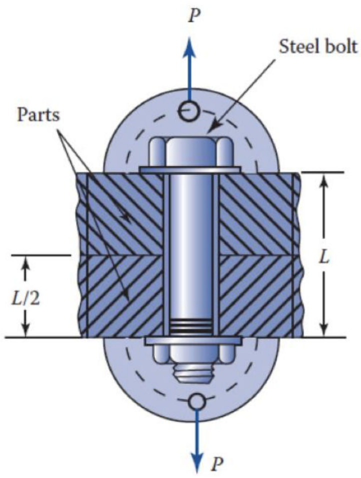
So from Table 15.1 (Ugeral) select ISO 5 x 0.8 steel bolt with tensile stress area closest to $A_t = 14.03\text{mm}^2$

Question 2

A bolted connection has been tightened by applying torque T to the nut with an initial preload load force $F_i = 4.2\text{kN}$ using M5 x 0.8 , ISO grade 4.6 steel blot, and resist an external load of $P = 5\text{kN}$. The clamped parts $L = 40\text{mm}$ and $k_p/k_b = 4$. Determine

- The tension in the bold and compression in the parts

- Whether parts will separate or remain in contact under the load



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Solution

$$F_b = \text{CP} + F_i = \left(\frac{k_b}{k_b + 4k_b}\right) \cdot 5 \times 10^3 + 4.2 \times 10^3$$

```
F_b = 1/5 * 5e3 + 4.2e3  %[N]
```

```
F_b = 5200
```

$$F_p = (1 - C)P - F_i = \left(1 - \frac{k_b}{k_b + 4k_b}\right) \cdot 5 \times 10^3 - 4.2 \times 10^3$$

```
F_p = (1 - 1/5) * 5e3 - 4.2e3  %[N]
```

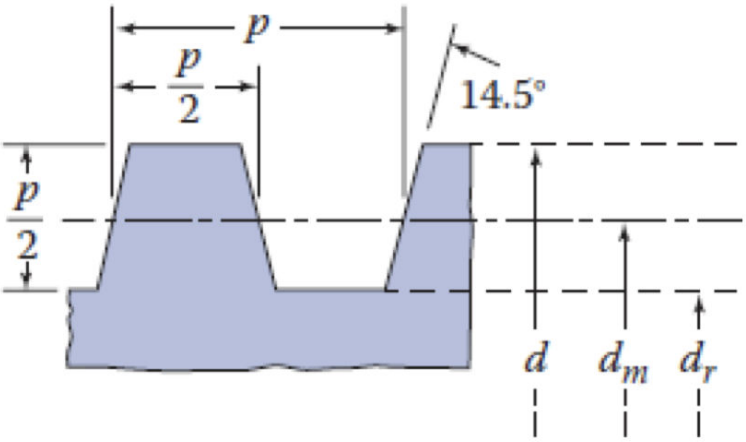
```
F_p = -200
```

There is a compression of -200N in the parts and therefore they do not separate under the 5kN load.

Question 3

A power screw is 75 mm in diameter and has a thread pitch of 15 mm using a single Acme thread. Determine the following parameters

- The thread depth
- The thread width
- The mean and root diameters
- The lead



Solution

The thread depth $\frac{p}{2}$

```
15/2  %[mm]
```

```
ans = 7.5000
```

The thread width $\frac{p}{2}$

```
15/2  %[mm]
```

```
ans = 7.5000
```

The mean diameter, $d_m = d - \frac{p}{2}$

```
d_m = 75 - 15/2  %[mm]
```

```
d_m = 67.5000
```

The root diameter, $d_r = d - p$

```
d_r = 75 - 15  %[mm]
```

```
d_r = 60
```

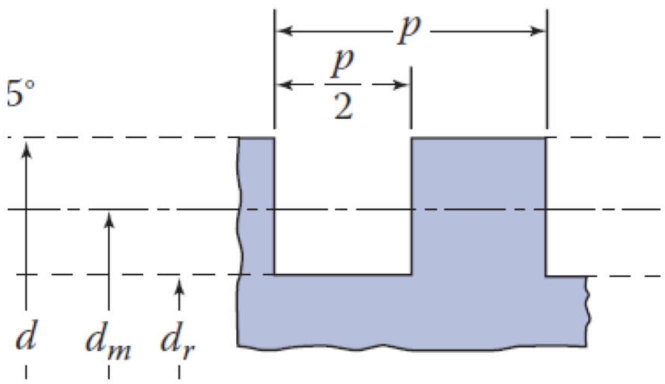
The lead, $L = p \cdot n$

```
L = 15 * 1  %[mm]
```

```
L = 15
```

Question 4

A 32 mm diameter (d) power screw has a double-square thread with a pitch of 4mm. The nut is move at a veloity of 40 mm/s to lift a load of W = 6 kN. Given the collar diameter is 50mm, the friction coefficients are $f = 0.1$ and $f_c = 0.15$. Determine the rotational speed and the torque to drive the power screw.



Thread angle $\alpha = 0$ for the square thread

Solution

Collar diameter

```
d_c = 50  %[mm]
```

```
d_c = 50
```

The mean diameter, $d_m = d - \frac{p}{2}$

```
d_m = 32 - 4/2  %[mm]
```

```
d_m = 30
```

The lead, $L = p \cdot n$

```
L = 2 * 4
```

```
L = 8
```

The lead angle, $\lambda = \tan^{-1}\frac{L}{\pi d_m}$

```
lambda = atand(L/(pi*d_m))
```

```
lambda = 4.8518
```

Torque to drive the power screw, $T_u = \frac{\mathrm{W d}_m}{2}\frac{f + \tan\lambda}{1 - f\tan\lambda} + \frac{W f_c d_c}{2}$

```
T_u = (6 * d_m) / 2 * (0.1 + tand(lambda)) / (1 - 0.1 * tand(lambda)) +
(6 * 0.15 * d_c) / 2  %[Nm]
```

```
T_u = 39.2819
```

Rotational speed, $n = \frac{v}{p}$

```
n = 40 / 8  %[rev/s]
```

```
n = 5
```