قائمة الاسئلة

تصميم عناصر الالات- كلية الهندسة - قسم الميكاترونكس - المستوى الثالث- 3ساعات - درجة هذا الاختبار (60)

د.عبدالله ذيبان

1)

$$P_r = P_t \tan \alpha$$

$$P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

ASME CODE FOR SHAFT DESIGN

One important approach of designing a transmission shaft is to use the ASME code. According to this code, the permissible shear stress $\tau_{max.}$ for the shaft without keyways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of the material, whichever is minimum. Therefore,

$\tau_{max.} = 0.30\, S_{yt}$

or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi\tau_{max.}}\sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
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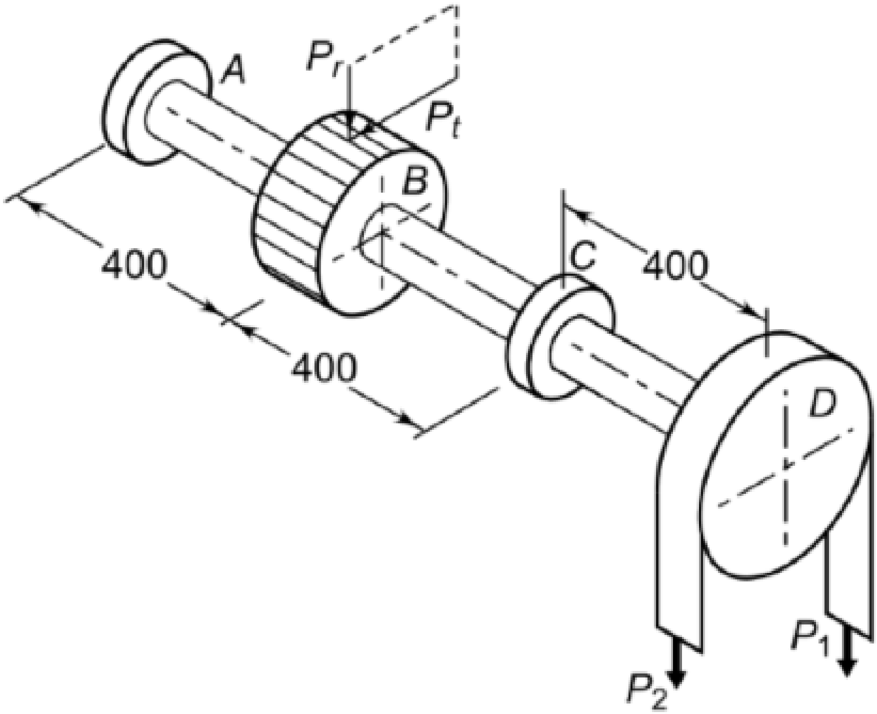

Q1) A steel shaft (material: 50C4, Sut=700 N/mm2, Syt=460 N/mm2) is supported by bearings A and C. It carries: A spur gear (with a 400 mm pitch diameter. A pulley (with a 450 mm diameter.
The pulley transmits 25 kW at 500 rpm to the gear. Given: Belt tensions: P1=3P2.
Gear forces: Pr=Pt x tan(20°). Using the ASME code (kb=kt=1.5)
Answer (Q 1-1)
1-1 What is the allowable shear stress (τmax) for the shaft material considering keyways?
1-2 How is the torsional moment (Mt) calculated?
1-3 What is the difference in belt tensions (P1−P2) for a the pulley?

1-4 What is the tangential force (Pt) on the gear ?
1-5 The radial force (Pr) is calculated using:
1-6 Where does the maximum bending moment occur on the shaft?
1-7 What is the bending moment at point C due to vertical forces?
1-8 What is the final shaft diameter (rounded to the nearest standard size)?

1) + 0.75×min(0.3Syt ,0.18Sut)
2) - 0.5×min(0.3Syt,0.18Sut)
3) - 0.75×max(Syt,Sut)
4) - 1.5×min(Syt,Sut)

2)

$P_r = P_t \tan\alpha$ $P_t = \frac{2M_t}{d'_p}$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

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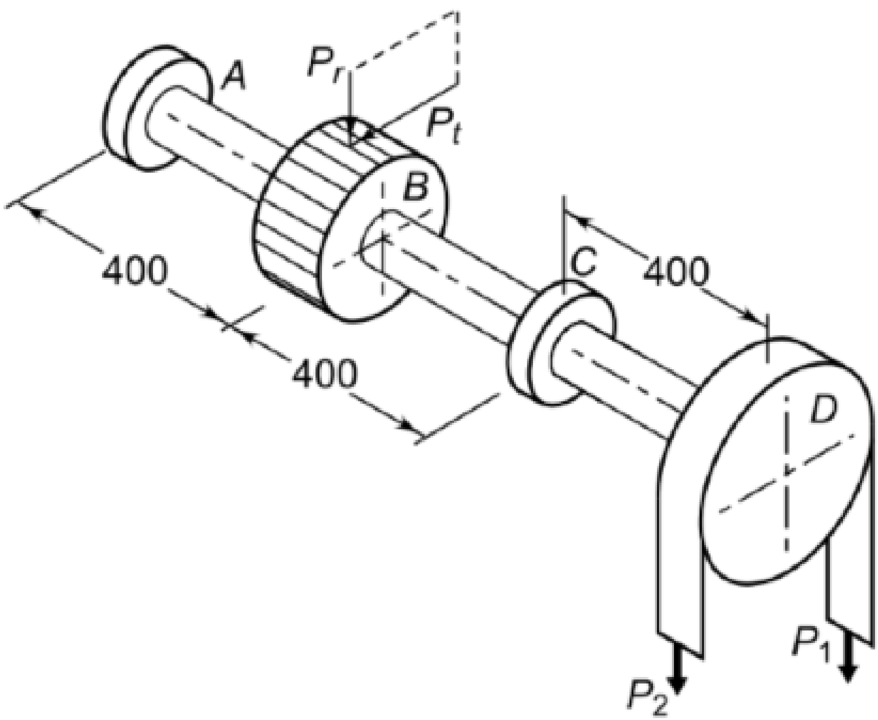

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The pulley transmits 25 kW at 500 rpm to the gear. Given: Belt tensions: P1=3P2.

–

Gear forces: Pr=Pt x tan(20). Using the ASME code (kb=kt=1.5)

Answer (Q 1-2)

1-1 What is the allowable shear stress (τmax) for the shaft material considering keyways?

1-2 How is the torsional moment (Mt) calculated?

1-3 What is the difference in belt tensions (P1−P2) for a the pulley?

1-4 What is the tangential force (Pt) on the gear ?

1-5 The radial force (Pr) is calculated using:

1-6 Where does the maximum bending moment occur on the shaft?

1-7 What is the bending moment at point C due to vertical forces?

1-8 What is the final shaft diameter (rounded to the nearest standard size)?

1) + 60×10^6×Power/2πn

2) - Power×n×60×10^6

3) - 2πn×60×10^6×Power

4) - Power×2πn

3)

$$P_t = \frac{2M_t}{d'_p}$$

$$P_r = P_t \tan\alpha$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

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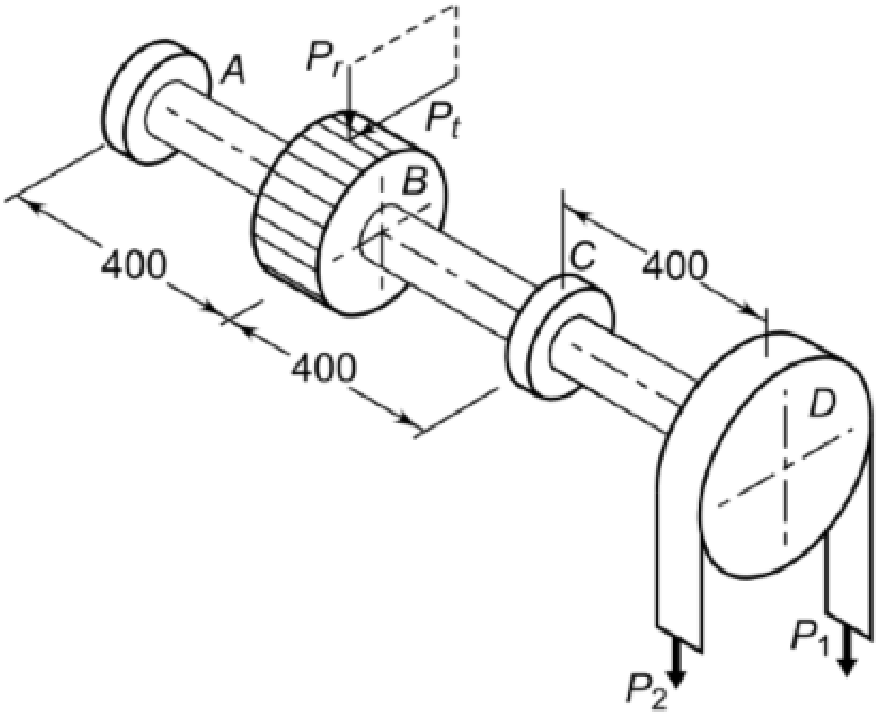

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Gear forces: Pr=Pt x tan(20□). Using the ASME code (kb=kt=1.5)
Answer (Q 1-3)
1-1 What is the allowable shear stress (τmax) for the shaft material considering keyways?
1-2 How is the torsional moment (Mt) calculated?
1-3 What is the difference in belt tensions (P1−P2) for a the pulley?
1-4 What is the tangential force (Pt) on the gear ?
1-5 The radial force (Pr) is calculated using:
1-6 Where does the maximum bending moment occur on the shaft?
1-7 What is the bending moment at point C due to vertical forces?
1-8 What is the final shaft diameter (rounded to the nearest standard size)?"

1) + 2,122.07 N
2) - 1,061.04 N
3) - 2,387.32 N
4) - 3,183.10 N

4)

$$P_t = \frac{2M_t}{d'_p}$$

$$P_r = P_t \tan \alpha$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

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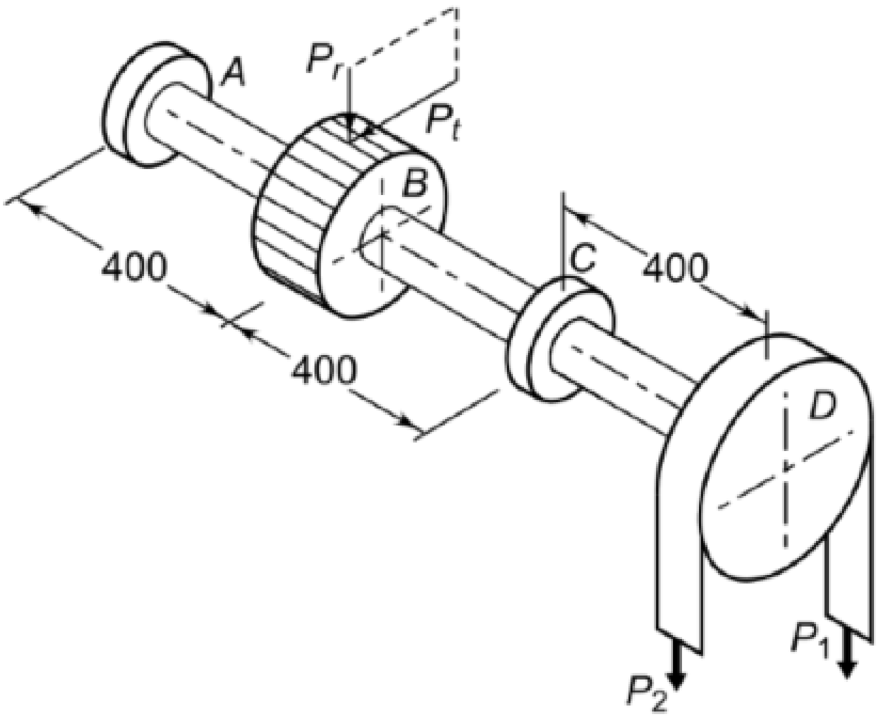

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Gear forces: Pr=Pt x tan(20□). Using the ASME code (kb=kt=1.5)
Answer (Q 1-4)
1-1 What is the allowable shear stress (τmax) for the shaft material considering keyways?
1-2 How is the torsional moment (Mt) calculated?
1-3 What is the difference in belt tensions (P1−P2) for a the pulley?
1-4 What is the tangential force (Pt) on the gear ?
1-5 The radial force (Pr) is calculated using:
1-6 Where does the maximum bending moment occur on the shaft?
1-7 What is the bending moment at point C due to vertical forces?

1-8 What is the final shaft diameter (rounded to the nearest standard size)?

1) + 477,464.83/200
2) - 477,464.83/400
3) - 477,464.83/150
4) - 477,464.83/225

5)

$P_r = P_t \tan\alpha$

$P_t = \frac{2M_t}{d'_p}$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

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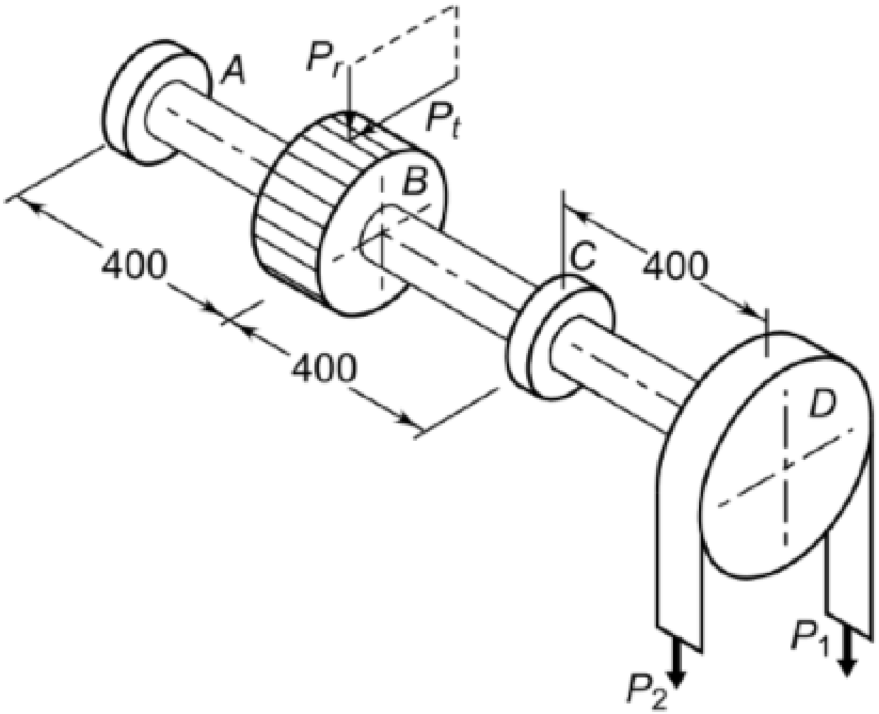

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Gear forces: Pr=Pt x tan(20□). Using the ASME code (kb=kt=1.5)
Answer (Q 1-5)
1-1 What is the allowable shear stress (τmax) for the shaft material considering keyways?
~~1-2~~ How is the torsional moment (Mt) calculated?

1-3 What is the difference in belt tensions (P1−P2) for a the pulley?
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1-5 The radial force (Pr) is calculated using:
1-6 Where does the maximum bending moment occur on the shaft?
1-7 What is the bending moment at point C due to vertical forces?
1-8 What is the final shaft diameter (rounded to the nearest standard size)?

1) + Pttan(20°)
2) - Ptsin(20°)
3) - Ptcos(20°)
4) - Ptcot(20°)

6)

$$P_r = P_t \tan\alpha \qquad P_t = \frac{2M_t}{d'_p}$$

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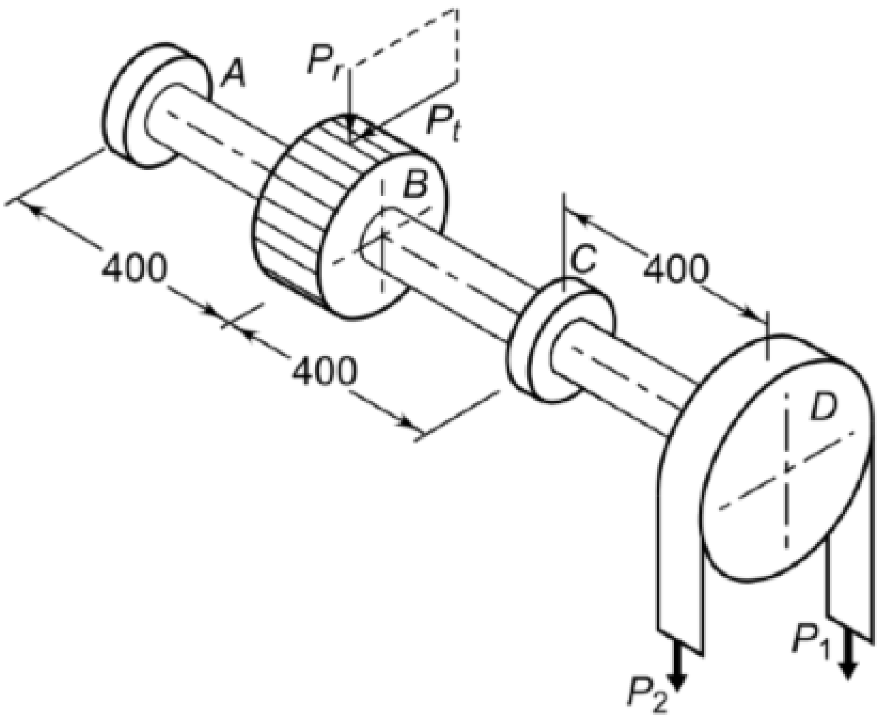

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The pulley transmits 25 kW at 500 rpm to the gear. Given: Belt tensions: P1=3P2.
Gear forces: Pr=Pt x tan(20□). Using the ASME code (kb=kt=1.5)
Answer (Q 1-6)
1-1 What is the allowable shear stress (τmax) for the shaft material considering keyways?
1-2 How is the torsional moment (Mt) calculated?
1-3 What is the difference in belt tensions (P1−P2) for a the pulley?
1-4 What is the tangential force (Pt) on the gear ?
1-5 The radial force (Pr) is calculated using:
1-6 Where does the maximum bending moment occur on the shaft?
1-7 What is the bending moment at point C due to vertical forces?
1-8 What is the final shaft diameter (rounded to the nearest standard size)?

1) + Point C (near pulley
2) - Point B (gear location)
3) - Point A (bearing)
4) - Midway between A and C

7)

$$P_t = \frac{2M_t}{d'_p}$$

$$P_r = P_t \tan\alpha$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

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$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

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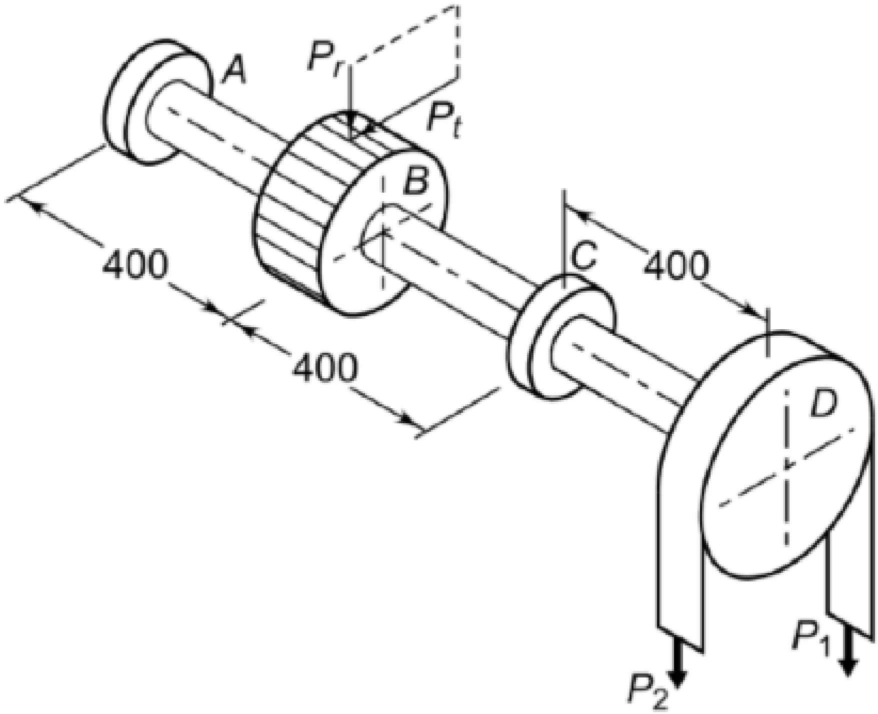

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Gear forces: Pr=Pt x tan(20□). Using the ASME code (kb=kt=1.5)
Answer (Q 1-7)
1-1 What is the allowable shear stress (τmax) for the shaft material considering keyways?
~~1-2 Ho~~w is the torsional moment (Mt) calculated?
1-3 What is the difference in belt tensions (P1−P2) for a the pulley?
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1-5 The radial force (Pr) is calculated using:
1-6 Where does the maximum bending moment occur on the shaft?
1-7 What is the bending moment at point C due to vertical forces?
1-8 What is the final shaft diameter (rounded to the nearest standard size)?

1) + 1,697,660 N-mm
2) - 347,644 N-mm
3) - 954,928 N-mm
4) - 955,500 N-mm

8)

$$P_t = \frac{2M_t}{d'_p}$$

$$P_r = P_t \tan \alpha$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

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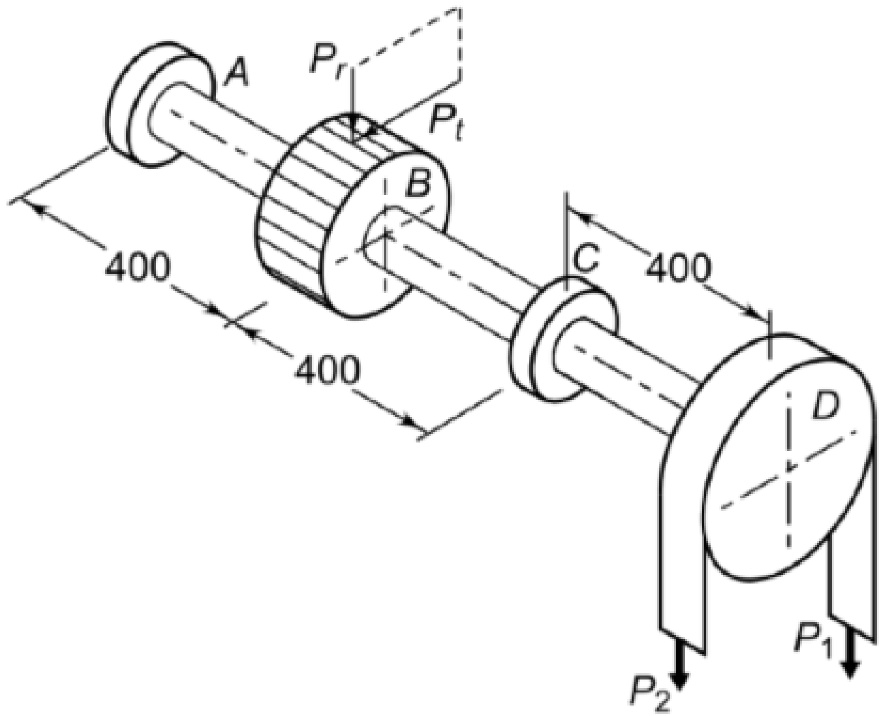

Q1) A steel shaft (material: 50C4, Sut=700 N/mm2, Syt=460 N/mm2) is supported by bearings A and C. It carries: A spur gear (with a 400 mm pitch diameter. A pulley (with a 450 mm diameter.
The pulley transmits 25 kW at 500 rpm to the gear. Given: Belt tensions: P1=3P2.
Gear forces: Pr=Pt x tan(20□). Using the ASME code (kb=kt=1.5)
Answer (Q 1-8)
1-1 What is the allowable shear stress (τmax) for the shaft material considering keyways?
~~1-2 How~~ is the torsional moment (Mt) calculated?
1-3 What is the difference in belt tensions (P1−P2) for a the pulley?
1-4 What is the tangential force (Pt) on the gear ?
1-5 The radial force (Pr) is calculated using:
1-6 Where does the maximum bending moment occur on the shaft?
1-7 What is the bending moment at point C due to vertical forces?

1-8 What is the final shaft diameter (rounded to the nearest standard size)?

1) + 55 mm
2) - 50 mm
3) - 60 mm
4) - 65 mm

9)

$P_r = P_t \tan \alpha$

$P_t = \frac{2M_t}{d'_p}$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

ASME CODE FOR SHAFT DESIGN

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$\tau_{max.} = 0.30\, S_{yt}$

or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi \tau_{max.}} \sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	*D*	*B*	*C*	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
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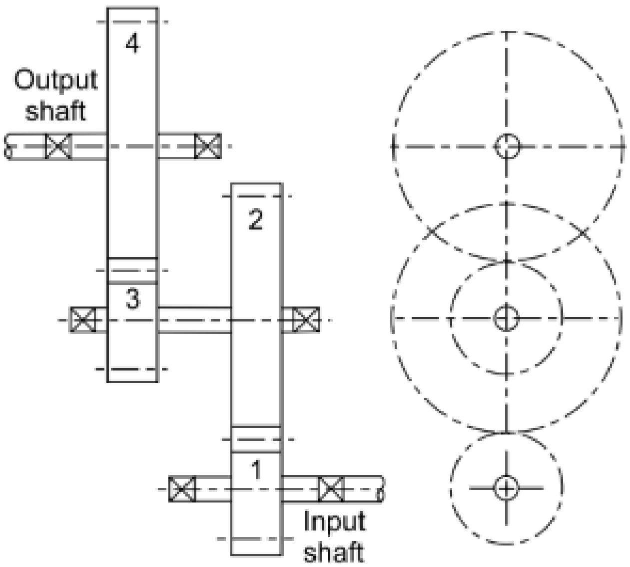

Q2: A train of spur gears is shown in Fig. Gear 1 is the driving gear and transmits 5 kW power at 720 rpm. The number of teeth on gears 1, 2, 3, and 4 are 20, 50, 30, and 60, respectively. The module for all gears is 4 mm, and the gears have a 20° full-depth involute profile

Answer Q(2-1)

2-1 What is the pitch diameter of Gear 1?

2-2 What is the pitch diameter of Gear 3?

2-3 What is the torque transmitted by Gear 1?

2-4 What is the tangential force between Gears 1 and 2?

2-5 What is the radial force between Gears 1 and 2?

2-6 What is the torque transmitted by Gear 3?
2-7 What is the tangential force between Gears 3 and 4?
2-8 What is the radial force between Gears 3 and 4?

1) + 80 mm
2) - 100 mm
3) - 60 mm
4) - 120 mm

10)

$$P_r = P_t \tan\alpha$$

$$P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
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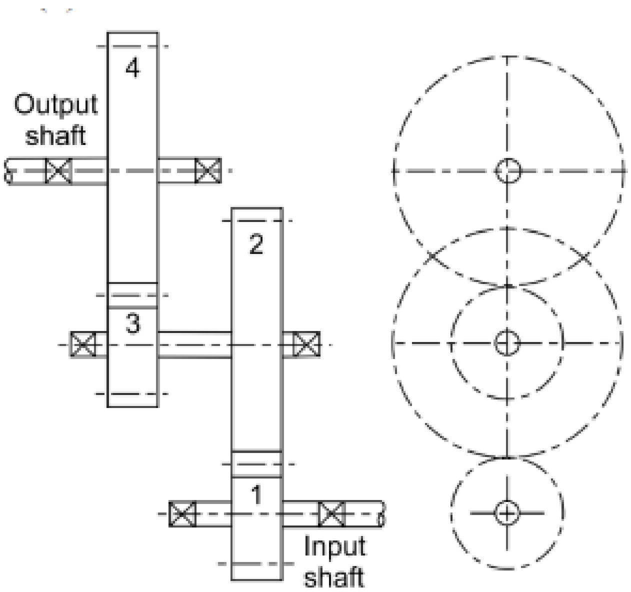

Q2: A train of spur gears is shown in Fig. Gear 1 is the driving gear and transmits 5 kW power at 720 rpm. The number of teeth on gears 1, 2, 3, and 4 are 20, 50, 30, and 60, respectively. The module for all gears is 4 mm, and the gears have a 20° full-depth involute profile
Answer Q(2-2)

2-1 What is the pitch diameter of Gear 1?
~~2~~-2 What is the pitch diameter of Gear 3?
2-3 What is the torque transmitted by Gear 1?

2-4 What is the tangential force between Gears 1 and 2?
2-5 What is the radial force between Gears 1 and 2?
2-6 What is the torque transmitted by Gear 3?
2-7 What is the tangential force between Gears 3 and 4?
2-8 What is the radial force between Gears 3 and 4?

1) + 120 mm
2) - 80 mm
3) - 100 mm
4) - 60 mm

11)

$P_t = \frac{2M_t}{d'_p}$

$P_r = P_t \tan\alpha$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
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20	32	7	2700	1500	61804
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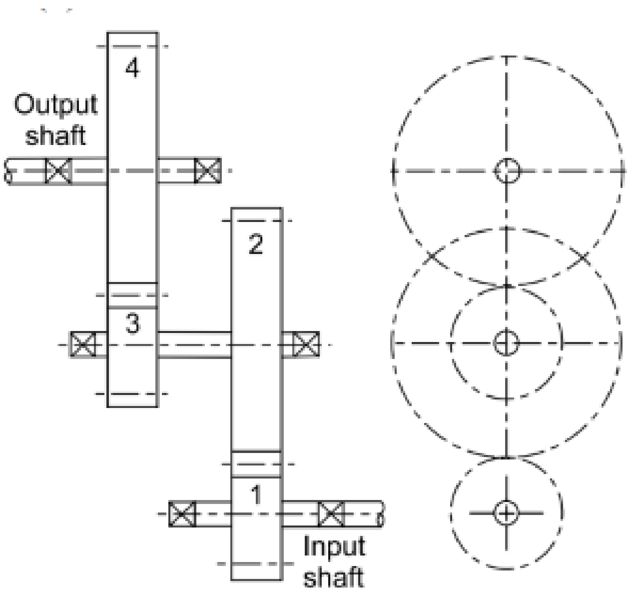

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Answer Q(2-3)

2-1 What is the pitch diameter of Gear 1?
—

2-2 What is the pitch diameter of Gear 3?
2-3 What is the torque transmitted by Gear 1?
2-4 What is the tangential force between Gears 1 and 2?
2-5 What is the radial force between Gears 1 and 2?
2-6 What is the torque transmitted by Gear 3?
2-7 What is the tangential force between Gears 3 and 4?
2-8 What is the radial force between Gears 3 and 4?

1) + 66,314.56 N-mm
2) - 50,000 N-mm
3) - 72,000 N-mm
4) - 60,000 N-mm

12)

$$P_r = P_t \tan\alpha \qquad P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
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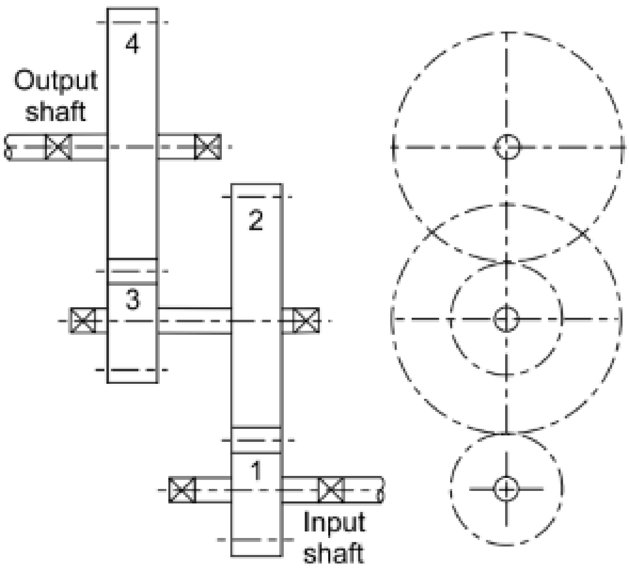

Q2: A train of spur gears is shown in Fig. Gear 1 is the driving gear and transmits 5 kW power at 720 rpm. The number of teeth on gears 1, 2, 3, and 4 are 20, 50, 30, and 60, respectively. The module for all gears is 4 mm, and the gears have a 20° full-depth involute profile
Answer Q(2-4)

2-1 What is the pitch diameter of Gear 1?
2-2 What is the pitch diameter of Gear 3?
2-3 What is the torque transmitted by Gear 1?
2-4 What is the tangential force between Gears 1 and 2?
2-5 What is the radial force between Gears 1 and 2?
2-6 What is the torque transmitted by Gear 3?
2-7 What is the tangential force between Gears 3 and 4?
2-8 What is the radial force between Gears 3 and 4?

1) + 1,657.86 N
2) - 1,500 N
3) - 1,800 N
4) - 2,000 N

13)

$$P_r = P_t \tan\alpha \qquad P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
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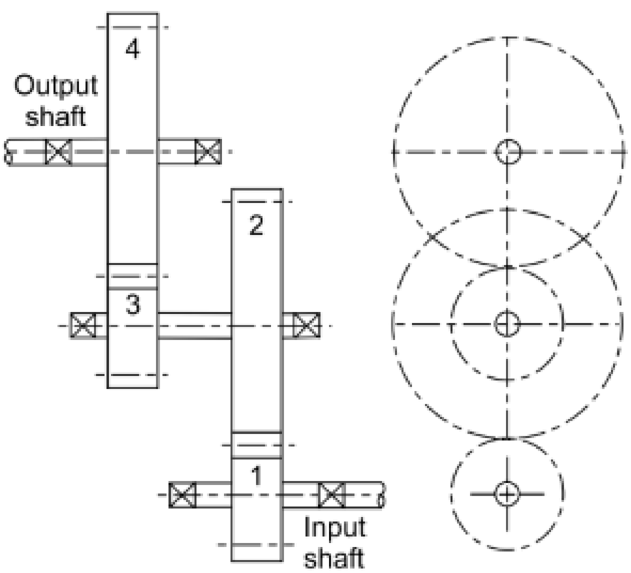

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mm, and the gears have a 20° full-depth involute profile
Answer Q(2-5)

2-1 What is the pitch diameter of Gear 1?
2-2 What is the pitch diameter of Gear 3?
2-3 What is the torque transmitted by Gear 1?
2-4 What is the tangential force between Gears 1 and 2?
2-5 What is the radial force between Gears 1 and 2?
2-6 What is the torque transmitted by Gear 3?
2-7 What is the tangential force between Gears 3 and 4?
2-8 What is the radial force between Gears 3 and 4?

1) + 603.41 N
2) - 500 N
3) - 700 N
4) - 800 N

14)

$$P_t = \frac{2M_t}{d'_p}$$

$$P_r = P_t \tan\alpha$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

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$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
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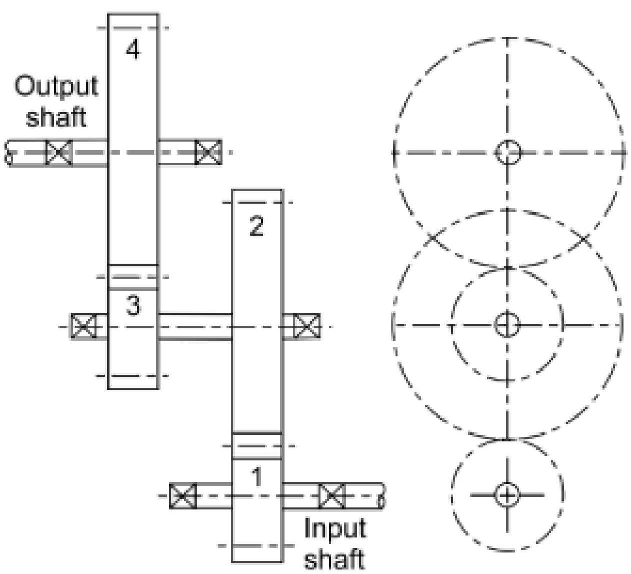

Q2: A train of spur gears is shown in Fig. Gear 1 is the driving gear and transmits 5 kW power at 720 rpm. The number of teeth on gears 1, 2, 3, and 4 are 20, 50, 30, and 60, respectively. The module for all gears is 4 mm, and the gears have a 20° full-depth involute profile
Answer Q(2-6)

2-1 What is the pitch diameter of Gear 1?
2-2 What is the pitch diameter of Gear 3?
2-3 What is the torque transmitted by Gear 1?
2-4 What is the tangential force between Gears 1 and 2?
2-5 What is the radial force between Gears 1 and 2?
2-6 What is the torque transmitted by Gear 3?
2-7 What is the tangential force between Gears 3 and 4?
2-8 What is the radial force between Gears 3 and 4?

1) + 165,786.4 N-mm
2) - 150,000 N-mm
3) - 170,000 N-mm
4) - 160,000 N-mm

15)

$$P_r = P_t \tan \alpha$$

$$P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

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Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
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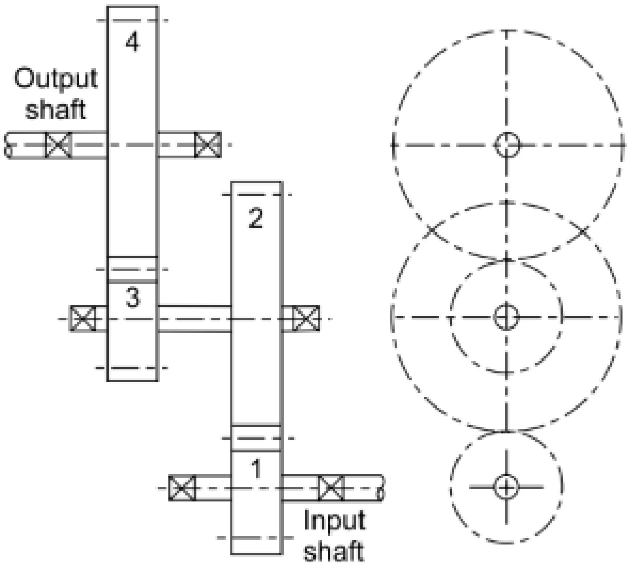

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Answer Q(2-7)

2-1 What is the pitch diameter of Gear 1?
~~2-2 Wh~~at is the pitch diameter of Gear 3?
2-3 What is the torque transmitted by Gear 1?
2-4 What is the tangential force between Gears 1 and 2?
2-5 What is the radial force between Gears 1 and 2?
2-6 What is the torque transmitted by Gear 3?
2-7 What is the tangential force between Gears 3 and 4?
2-8 What is the radial force between Gears 3 and 4?

1) + 2,763.11 N
2) - 2,500 N
3) - 3,000 N
4) - 2,800 N

16)

$$P_r = P_t \tan\alpha \qquad P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

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d	D	B	C	C_0	
10	19	5	1480	630	61800
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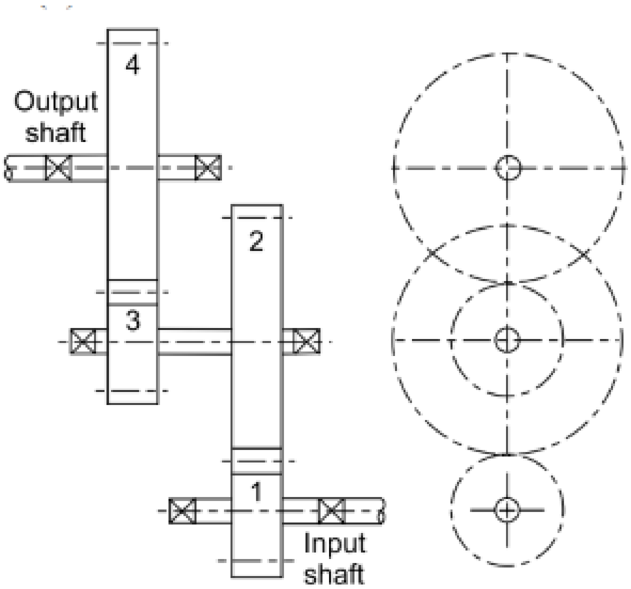

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Answer Q(2-8)

2-1 What is the pitch diameter of Gear 1?

~~2-2 What~~ is the pitch diameter of Gear 3?

2-3 What is the torque transmitted by Gear 1?

2-4 What is the tangential force between Gears 1 and 2?

2-5 What is the radial force between Gears 1 and 2?

2-6 What is the torque transmitted by Gear 3?

2-7 What is the tangential force between Gears 3 and 4?

2-8 What is the radial force between Gears 3 and 4?

1)	+	1,005.69 N
2)	-	900 N

3) - 1,100 N
4) - 1,200 N

17)

$$P_t = \frac{2M_t}{d'_p}$$

$$P_r = P_t \tan \alpha$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

ASME CODE FOR SHAFT DESIGN

One important approach of designing a transmission shaft is to use the ASME code. According to this code, the permissible shear stress $\tau_{max.}$ for the shaft without keyways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of the material, whichever is minimum. Therefore,

$\tau_{max.} = 0.30\, S_{yt}$

or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi \tau_{max.}} \sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

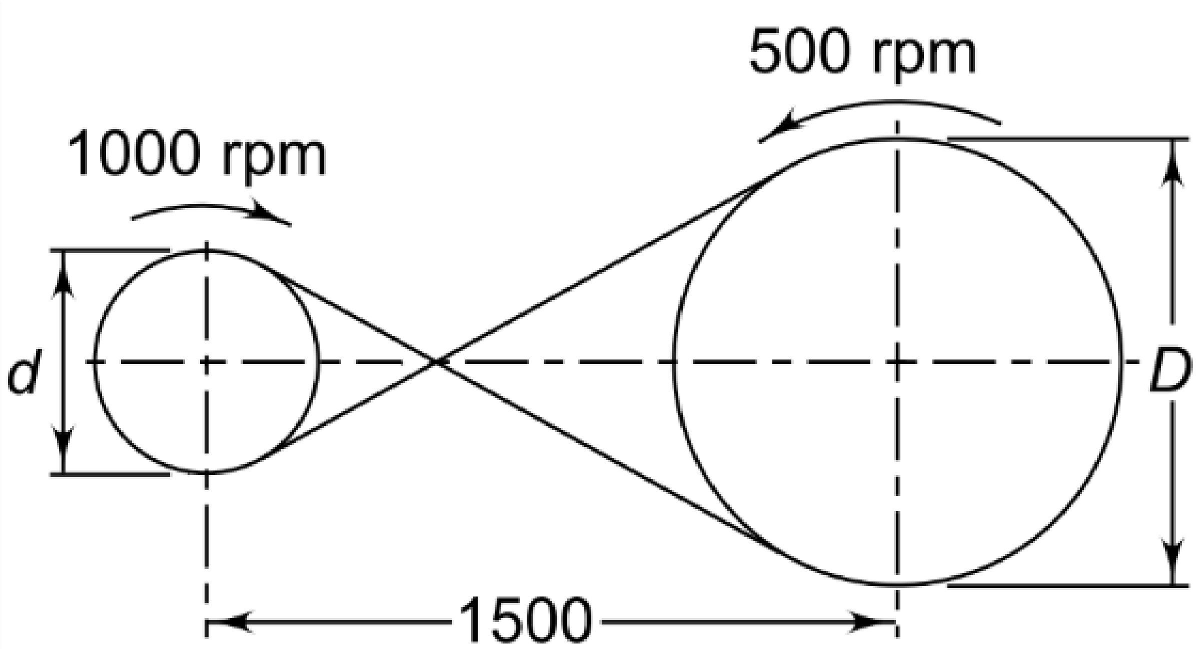
$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	*D*	*B*	*C*	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404



Q3: A crossed leather belt drive transmits 7.5 kW of power at a belt velocity of 13 m/s. The belt is 6 mm thick, and the coefficient of friction between the belt and pulleys is 0.3. The permissible tensile stress for the belt material is 1.75 N/mm², and the density of leather is 0.95 g/cc.

Answer (Q 3.1)

3-1 What is the diameter of the smaller pulley? Round off to the nearest standard size

3-2 What is the diameter of the larger pulley?

3-3 What is the length of the belt?

3-4 What is the angle of wrap (in degrees)?

3-5 What is the exponential term eμα?

3-6 What is the width of the belt?

3-7 What is the tight-side tension (P1)?

3-8 What is the loose-side tension (P2)?

1) + 250 mm

2) - 300 mm

3) - 200 mm

4) - 350 mm

18)

$$P_r = P_t \tan \alpha \qquad P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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$\tau_{max.} = 0.30\, S_{yt}$

or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

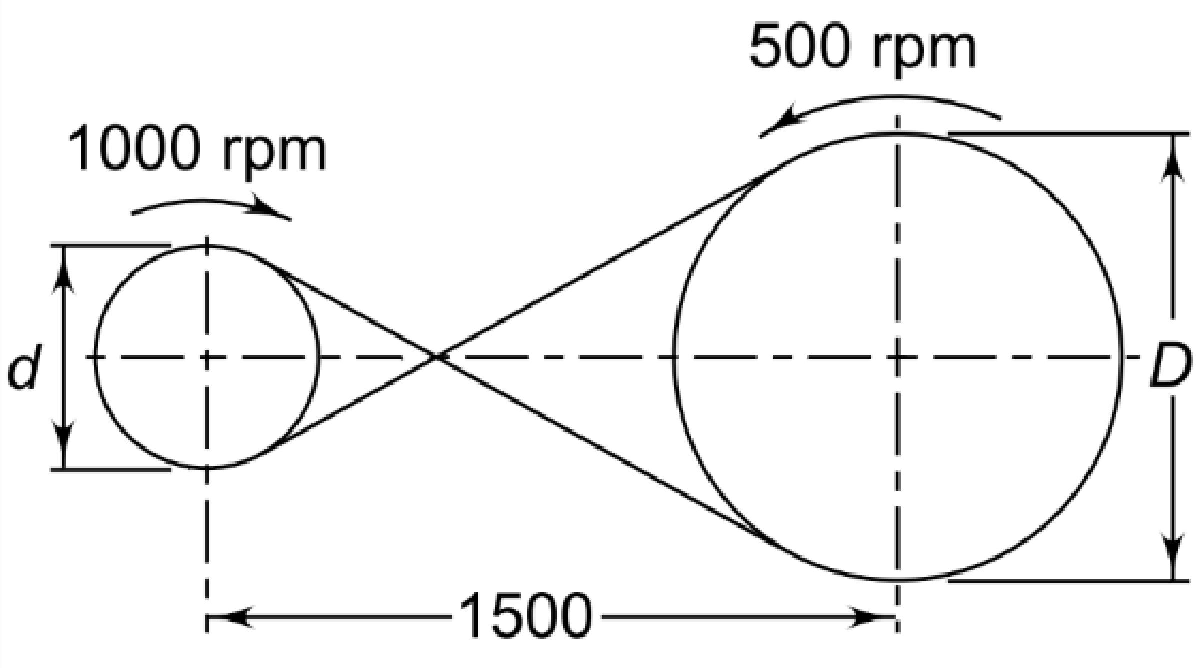
If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi \tau_{max.}} \sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			*Basic load ratings (N)*		*Designation*
d	*D*	*B*	*C*	*C_0*	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404



Q3: A crossed leather belt drive transmits 7.5 kW of power at a belt velocity of 13 m/s. The belt is 6 mm thick, and the coefficient of friction between the belt and pulleys is 0.3. The permissible tensile stress for the belt material is 1.75 N/mm², and the density of leather is 0.95 g/cc.

Answer (Q 3.2)

3-1 What is the diameter of the smaller pulley? Round off to the nearest standard size

3-2 What is the diameter of the larger pulley?

3-3 What is the length of the belt?
3-4 What is the angle of wrap (in degrees)?
3-5 What is the exponential term eμα?
3-6 What is the width of the belt?
3-7 What is the tight-side tension (P1)?
3-8 What is the loose-side tension (P2)?

1) + 500 mm
2) - 600 mm
3) - 450 mm
4) - 400 mm

19)

$$P_r = P_t \tan \alpha$$

$$P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi\tau_{max.}}\sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
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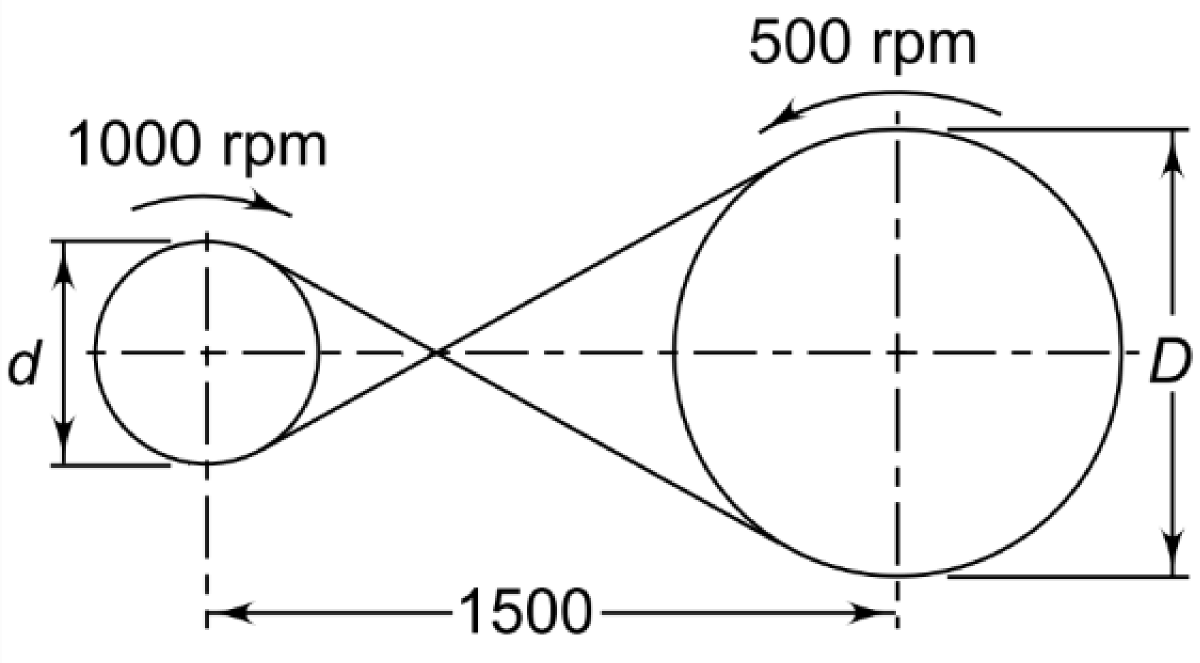

Q3: A crossed leather belt drive transmits 7.5 kW of power at a belt velocity of 13 m/s. The belt is 6 mm thick, and the coefficient of friction between the belt and pulleys is 0.3. The permissible tensile stress for the

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belt material is 1.75 N/mm², and the density of leather is 0.95 g/cc.
Answer (Q 3.3)
3-1 What is the diameter of the smaller pulley? Round off to the nearest standard size
3-2 What is the diameter of the larger pulley?
3-3 What is the length of the belt?
3-4 What is the angle of wrap (in degrees)?
3-5 What is the exponential term eμα?
3-6 What is the width of the belt?
3-7 What is the tight-side tension (P1)?
3-8 What is the loose-side tension (P2)?

1) + 4271.85 mm
2) - 4000 mm
3) - 4500 mm
4) - 3800 mm

20)

$$P_r = P_t \tan \alpha$$

$$P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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One important approach of designing a transmission shaft is to use the ASME code. According to this code, the permissible shear stress $\tau_{max.}$ for the shaft without keyways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of the material, whichever is minimum. Therefore,

$\tau_{max.} = 0.30\, S_{yt}$

or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi \tau_{max.}} \sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

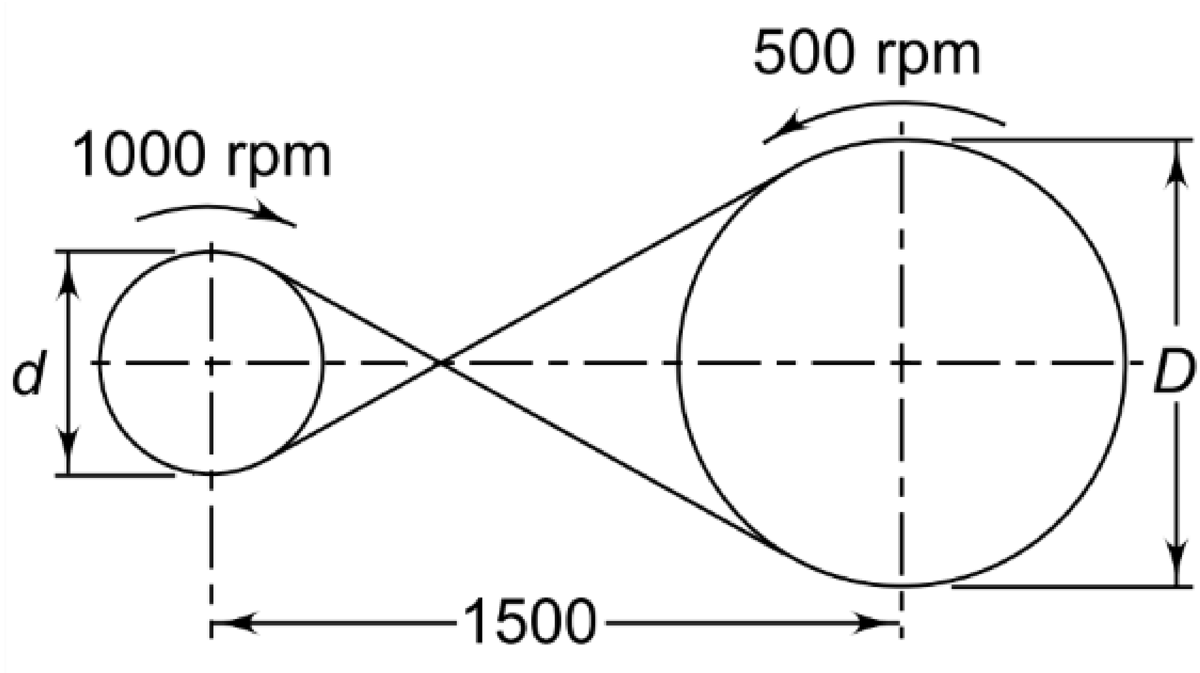
$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404



Q3: A crossed leather belt drive transmits 7.5 kW of power at a belt velocity of 13 m/s. The belt is 6 mm thick, and the coefficient of friction between the belt and pulleys is 0.3. The permissible tensile stress for the belt material is 1.75 N/mm², and the density of leather is 0.95 g/cc.

Answer (Q 3.4)

3-1 What is the diameter of the smaller pulley? Round off to the nearest standard size

3-2 What is the diameter of the larger pulley?

3-3 What is the length of the belt?

3-4 What is the angle of wrap (in degrees)?

3-5 What is the exponential term eμα?

3-6 What is the width of the belt?

3-7 What is the tight-side tension (P1)?

3-8 What is the loose-side tension (P2)?

1) + 208.96°

2) - 180°

3) - 220°

4) - 195°

21)

$P_r = P_t \tan\alpha$

$P_t = \frac{2M_t}{d'_p}$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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One important approach of designing a transmission shaft is to use the ASME code. According to this code, the permissible shear stress $\tau_{max.}$ for the shaft without keyways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of the material, whichever is minimum. Therefore,

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or, $\tau_{max.} = 0.18\,S_{ut}$ (whichever is minimum)

If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi\tau_{max.}}\sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
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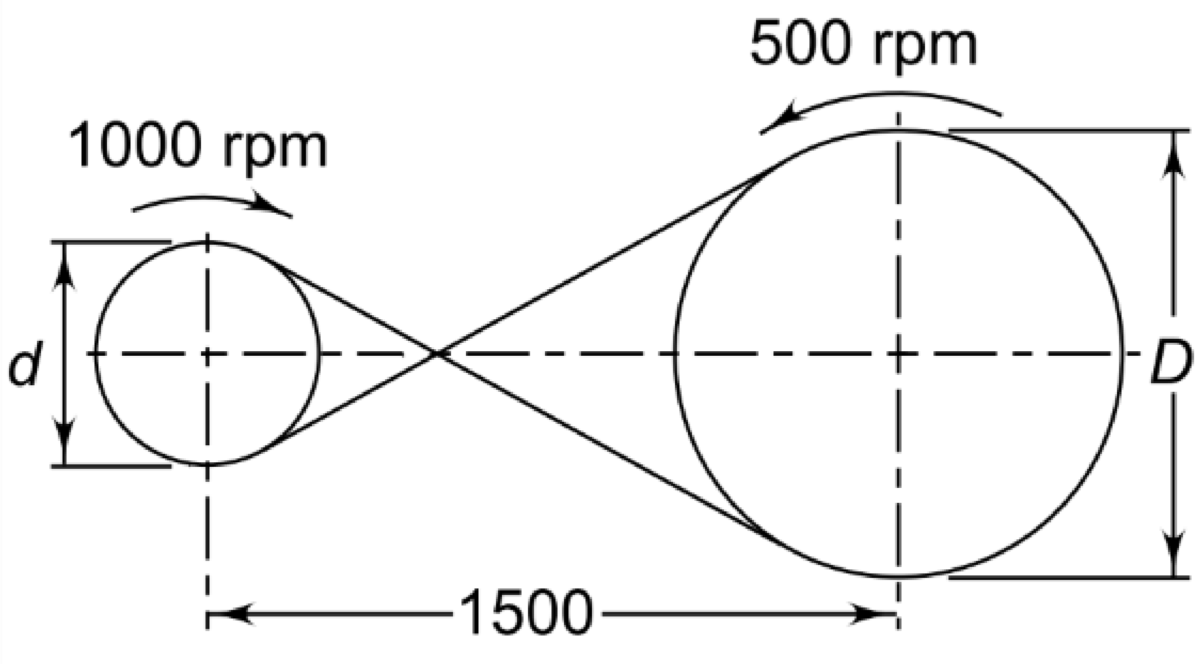
	72	19	30700	16600	6404



Q3: A crossed leather belt drive transmits 7.5 kW of power at a belt velocity of 13 m/s. The belt is 6 mm thick, and the coefficient of friction between the belt and pulleys is 0.3. The permissible tensile stress for the belt material is 1.75 N/mm^2, and the density of leather is 0.95 g/cc.

Answer (Q 3.5)

3-1 What is the diameter of the smaller pulley? Round off to the nearest standard size

~~3-2~~ What is the diameter of the larger pulley?

3-3 What is the length of the belt?

3-4 What is the angle of wrap (in degrees)?

3-5 What is the exponential term eμα?

3-6 What is the width of the belt?

3-7 What is the tight-side tension (P1)?

3-8 What is the loose-side tension (P2)?

1)	+	2.99
2)	-	2.5
3)	-	3.14
4)	-	1.85

22)

$$P_t = \frac{2M_t}{d'_p}$$

$$P_r = P_t \tan \alpha$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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One important approach of designing a transmission shaft is to use the ASME code. According to this code, the permissible shear stress $\tau_{max.}$ for the shaft without keyways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of the material, whichever is minimum. Therefore,

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or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi \tau_{max.}} \sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
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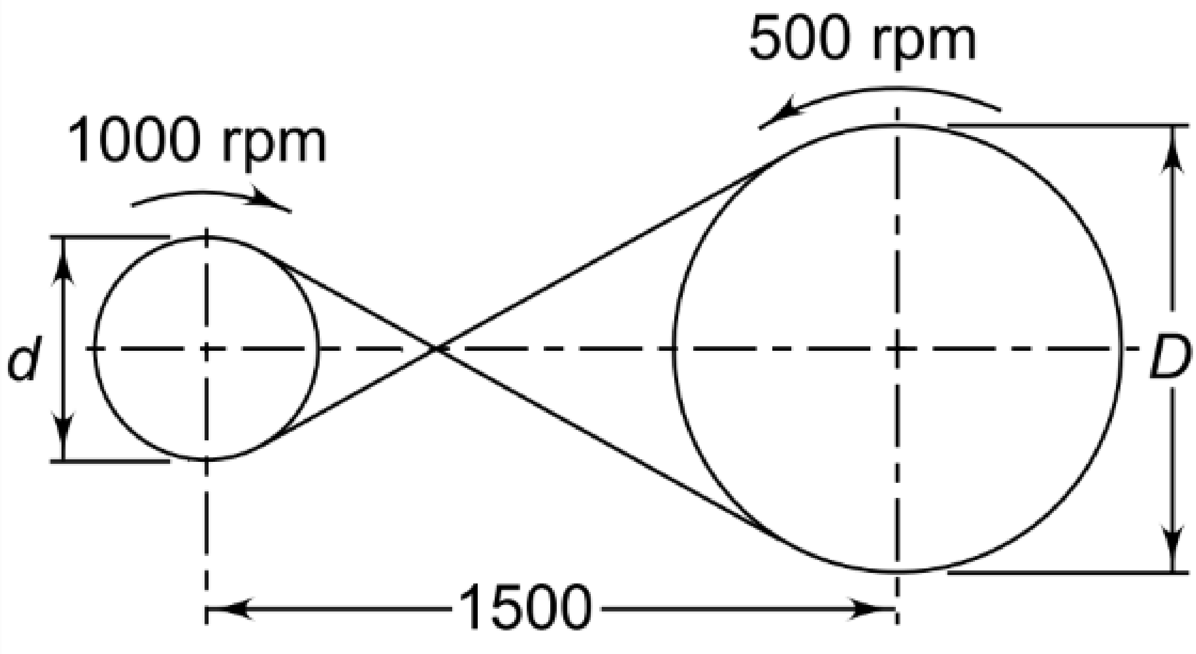

Q3: A crossed leather belt drive transmits 7.5 kW of power at a belt velocity of 13 m/s. The belt is 6 mm thick, and the coefficient of friction between the belt and pulleys is 0.3. The permissible tensile stress for the belt material is 1.75 N/mm², and the density of leather is 0.95 g/cc.

Answer (Q 3.6)

3-1 What is the diameter of the smaller pulley? Round off to the nearest standard size
3-2 What is the diameter of the larger pulley?
3-3 What is the length of the belt?
3-4 What is the angle of wrap (in degrees)?
3-5 What is the exponential term eμα?
3-6 What is the width of the belt?
3-7 What is the tight-side tension (P1)?
3-8 What is the loose-side tension (P2)?

1)	+	90.4 mm
2)	-	80 mm
3)	-	100 mm
4)	-	75 mm

23)

$$P_t = \frac{2M_t}{d'_p}$$

$$P_r = P_t \tan \alpha$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi \tau_{max.}} \sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
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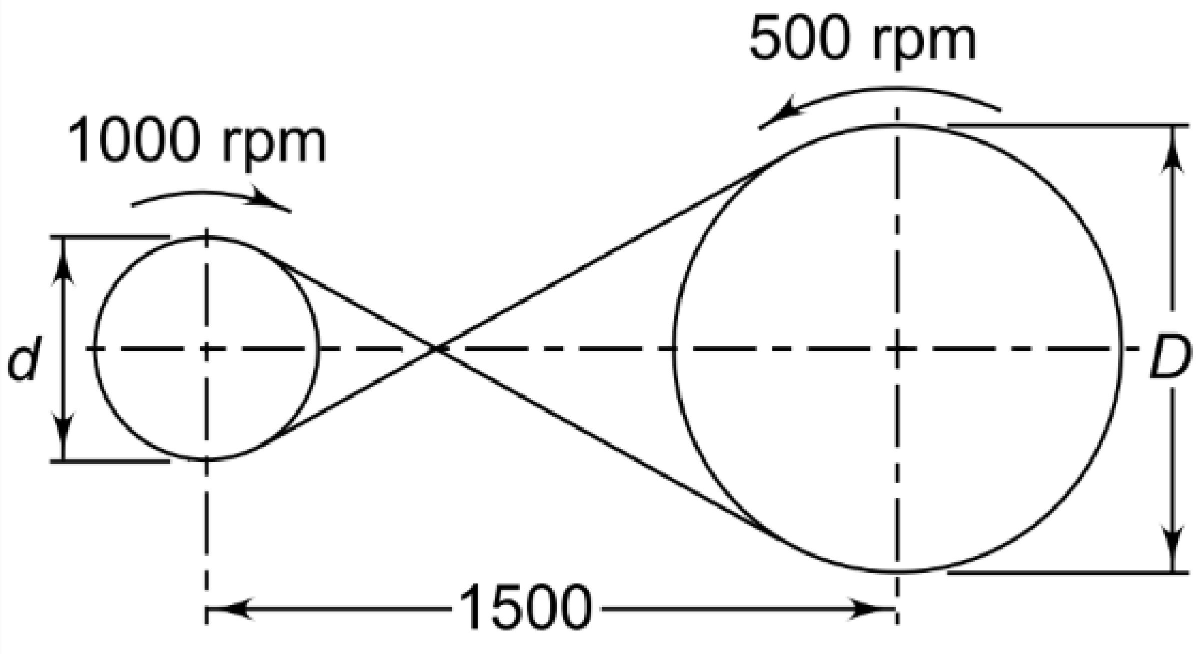

Q3: A crossed leather belt drive transmits 7.5 kW of power at a belt velocity of 13 m/s. The belt is 6 mm thick, and the coefficient of friction between the belt and pulleys is 0.3. The permissible tensile stress for the belt material is 1.75 N/mm², and the density of leather is 0.95 g/cc.
Answer (Q 3.7)
3-1 What is the diameter of the smaller pulley? Round off to the nearest standard size
3-2 What is the diameter of the larger pulley?
3-3 What is the length of the belt?
3-4 What is the angle of wrap (in degrees)?
3-5 What is the exponential term eμα?
3-6 What is the width of the belt?
3-7 What is the tight-side tension (P1)?
3-8 What is the loose-side tension (P2)?

1)	+	949.2 N
2)	-	800 N
3)	-	1100 N
4)	-	700 N

24)

$$P_t = \frac{2M_t}{d'_p}$$

$$P_r = P_t \tan \alpha$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi \tau_{max.}} \sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
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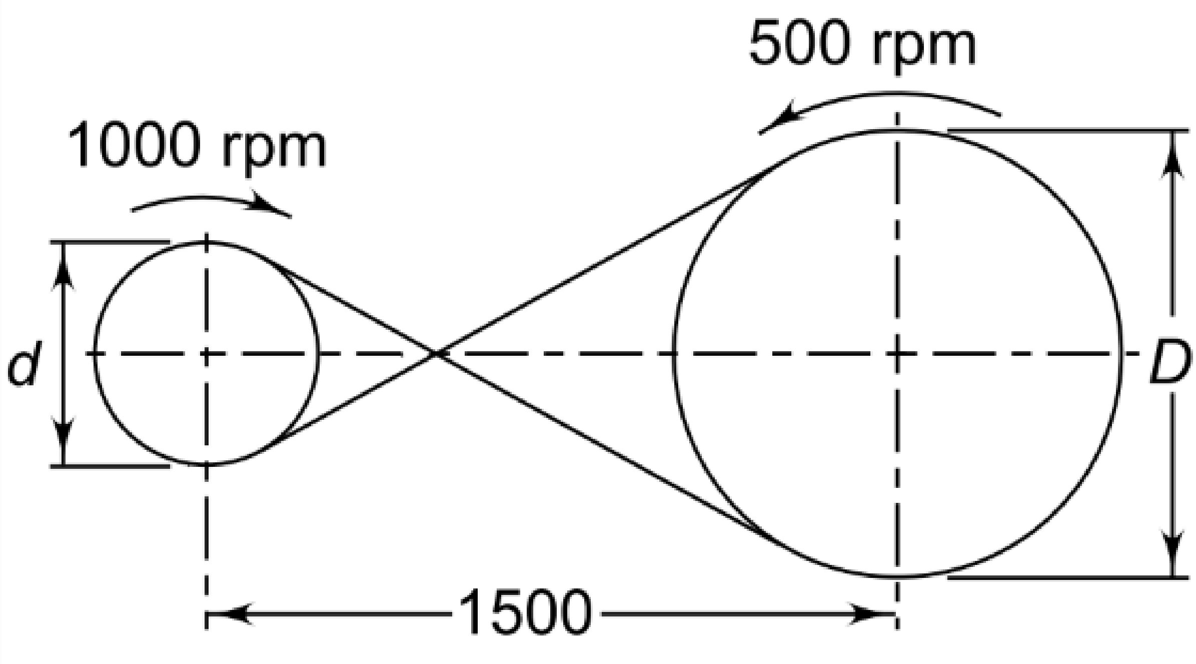

Q3: A crossed leather belt drive transmits 7.5 kW of power at a belt velocity of 13 m/s. The belt is 6 mm thick, and the coefficient of friction between the belt and pulleys is 0.3. The permissible tensile stress for the belt material is 1.75 N/mm², and the density of leather is 0.95 g/cc.

Answer (Q 3.8)

3-1 What is the diameter of the smaller pulley? Round off to the nearest standard size

3-2 What is the diameter of the larger pulley?

3-3 What is the length of the belt?

3-4 What is the angle of wrap (in degrees)?

3-5 What is the exponential term eμα?

3-6 What is the width of the belt?

3-7 What is the tight-side tension (P1)?

3-8 What is the loose-side tension (P2)?

1) + 376.24 N
2) - 500 N
3) - 300 N
4) - 450 N

25)

$$P_r = P_t \tan \alpha \qquad P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180° + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

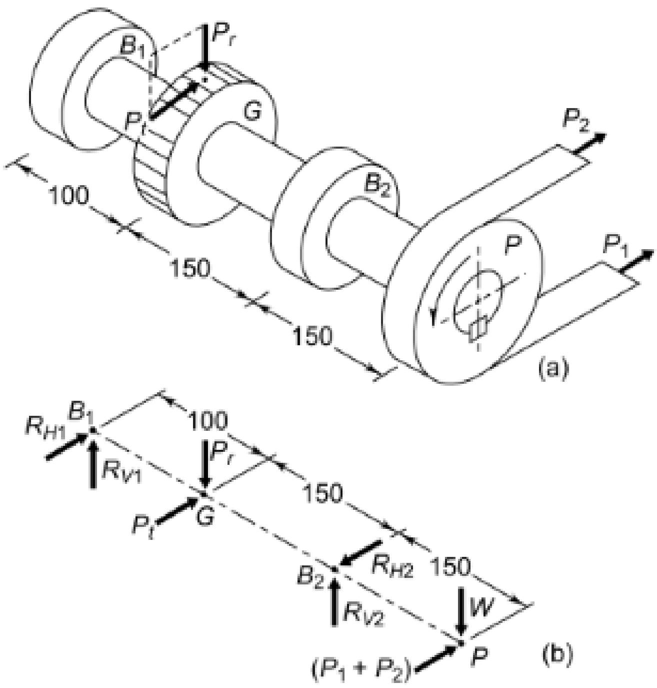
If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi \tau_{max.}} \sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404



Q4: A transmission shaft rotates at 720 rpm, transmitting power from a pulley (P) to a spur gear (G). The forces are:

• Belt tensions: P1=498 N, P2=166 N
• Gear forces: Pt=497 N, Pr=181 N
• Pulley weight: W=100 N
• Shaft diameters at bearings B1 and B2: 10 mm and 20 mm
• Load factor: 2.5
• Required bearing life (L10h): 8000 hours

Answer (Q 4.1)

4.1. What is the vertical reaction force (RV1) at bearing B1?

4.2. What is the horizontal reaction force (RH2) at bearing B2?

4.3. What is the total radial force (Fr1) at bearing B1?
4.4. What is the dynamic load capacity (C1) for bearing B1?
4.5. Which bearing is selected for B2 (20 mm shaft)?
4.6. What is the bearing life (L10) in million revolutions?
4.7. What load factor is applied to calculate dynamic load capacity?
4.8. What is the final bearing selection for B1 (10 mm shaft)?

1) + 48.6 N
2) - 232.4 N
3) - 181 N
4) - 100 N

26)

$P_r = P_t \tan\alpha$

$P_t = \frac{2M_t}{d'_p}$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180° + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

ASME CODE FOR SHAFT DESIGN

One important approach of designing a transmission shaft is to use the ASME code. According to this code, the permissible shear stress $\tau_{max.}$ for the shaft without keyways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of the material, whichever is minimum. Therefore,

$\tau_{max.} = 0.30\, S_{yt}$

or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi\tau_{max.}}\sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

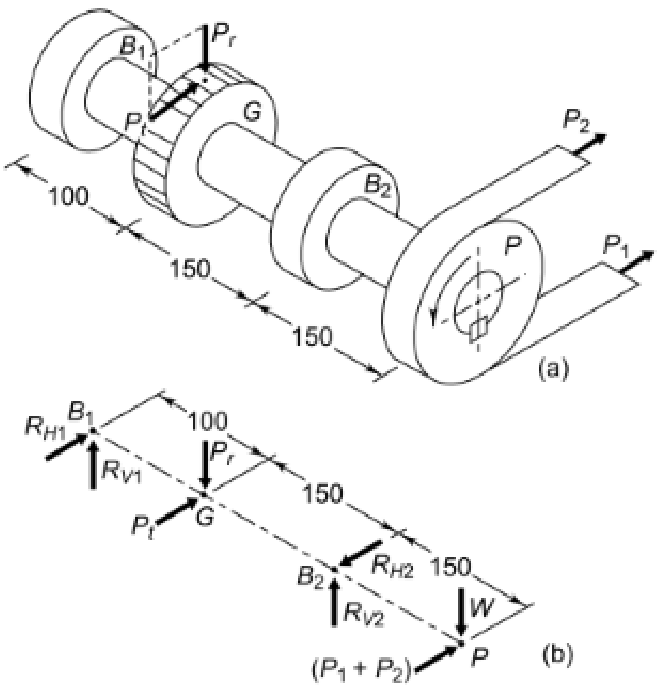
$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C}$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404



Q4: A transmission shaft rotates at 720 rpm, transmitting power from a pulley (P) to a spur gear (G). The

forces are:

• Belt tensions: P1=498 N, P2=166 N
• Gear forces: Pt=497 N, Pr=181 N
• Pulley weight: W=100 N
• Shaft diameters at bearings B1 and B2: 10 mm and 20 mm
• Load factor: 2.5
• Required bearing life (L10h): 8000 hours

Answer (Q 4.2)

4.1. What is the vertical reaction force (RV1) at bearing B1?
4.2. What is the horizontal reaction force (RH2) at bearing B2?
4.3. What is the total radial force (Fr1) at bearing B1?
4.4. What is the dynamic load capacity (C1) for bearing B1?
4.5. Which bearing is selected for B2 (20 mm shaft)?
4.6. What is the bearing life (L10) in million revolutions?
4.7. What load factor is applied to calculate dynamic load capacity?
4.8. What is the final bearing selection for B1 (10 mm shaft)?

1) + 1261.2 N
2) - 100.2 N
3) - 497 N
4) - 664 N

27)

$$P_r = P_t \tan\alpha \qquad P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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$\tau_{max.} = 0.30\, S_{yt}$

or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

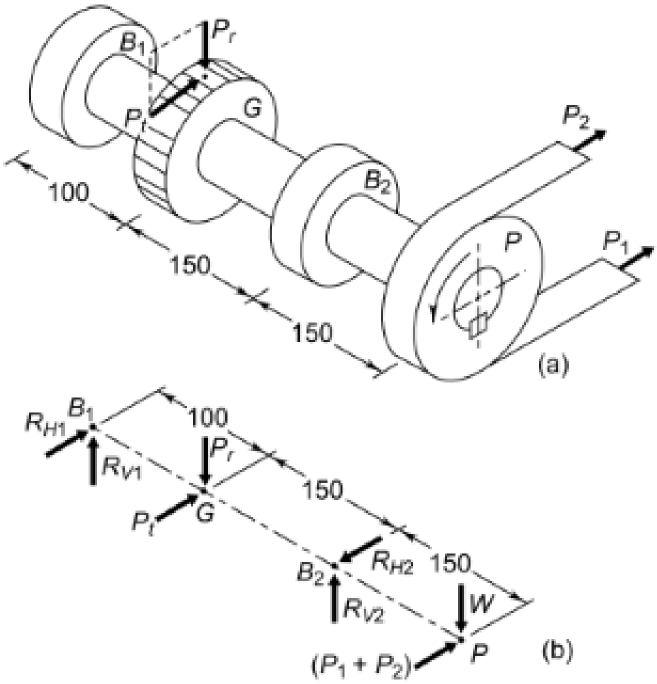
If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi\tau_{max.}}\sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	*D*	*B*	*C*	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404



"Q4: A transmission shaft rotates at 720 rpm, transmitting power from a pulley (P) to a spur gear (G). The forces are:
• Belt tensions: P1=498 N, P2=166 N
• Gear forces: Pt=497 N, Pr=181 N
• Pulley weight: W=100 N
• Shaft diameters at bearings B1 and B2: 10 mm and 20 mm
• Load factor: 2.5
• Required bearing life (L10h): 8000 hours
Answer (Q 4.3)
4.1. What is the vertical reaction force (RV1) at bearing B1?
4.2. What is the horizontal reaction force (RH2) at bearing B2?
4.3. What is the total radial force (Fr1) at bearing B1?
4.4. What is the dynamic load capacity (C1) for bearing B1?
4.5. Which bearing is selected for B2 (20 mm shaft)?
4.6. What is the bearing life (L10) in million revolutions?
4.7. What load factor is applied to calculate dynamic load capacity?
4.8. What is the final bearing selection for B1 (10 mm shaft)?"

1) + 111.36 N
2) - 232.4 N
3) - 1282.43 N
4) - 497 N

28)

$$P_t = \frac{2M_t}{d'_p}$$

$$P_r = P_t \tan \alpha$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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$\tau_{max.} = 0.30\, S_{yt}$

or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

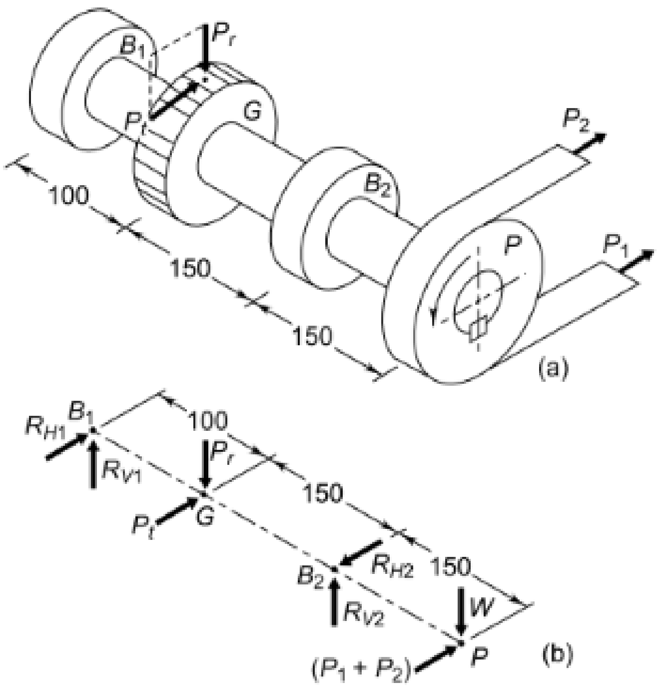
If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi \tau_{max.}} \sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404



"Q4: A transmission shaft rotates at 720 rpm, transmitting power from a pulley (P) to a spur gear (G). The forces are:

• Belt tensions: P1=498 N, P2=166 N
• Gear forces: Pt=497 N, Pr=181 N
• Pulley weight: W=100 N
• Shaft diameters at bearings B1 and B2: 10 mm and 20 mm
• Load factor: 2.5
• Required bearing life (L10h): 8000 hours

Answer (Q 4.4)

4.1. What is the vertical reaction force (RV1) at bearing B1?

4.2. What is the horizontal reaction force (RH2) at bearing B2?

4.3. What is the total radial force (Fr1) at bearing B1?
4.4. What is the dynamic load capacity (C1) for bearing B1?
4.5. Which bearing is selected for B2 (20 mm shaft)?
4.6. What is the bearing life (L10) in million revolutions?
4.7. What load factor is applied to calculate dynamic load capacity?
4.8. What is the final bearing selection for B1 (10 mm shaft)?"

1) + 1953.71 N
2) - 22499.09 N
3) - 111.36 N
4) - 345.6 N

29)

$$P_r = P_t \tan\alpha \qquad P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

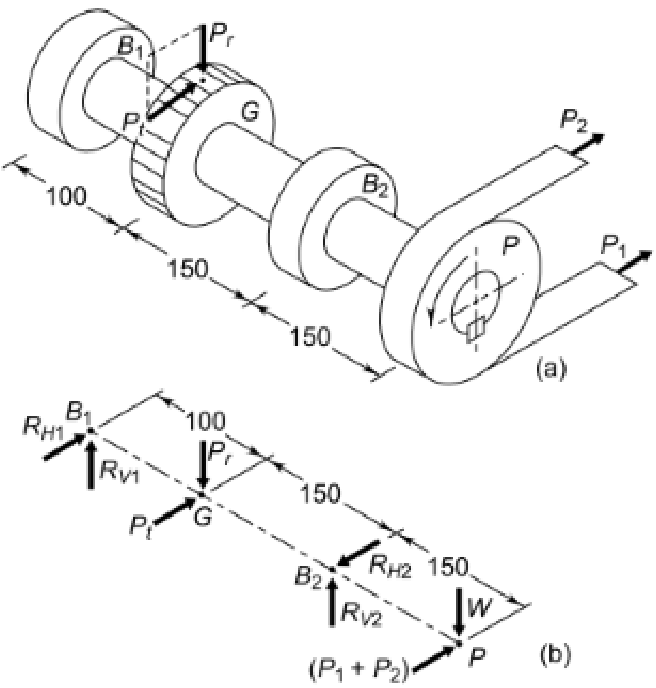
If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi\tau_{max.}}\sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404



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• Gear forces: Pt=497 N, Pr=181 N
• Pulley weight: W=100 N
• Shaft diameters at bearings B1 and B2: 10 mm and 20 mm
• Load factor: 2.5
• Required bearing life (L10h): 8000 hours

Answer (Q 4.5)

4.1. What is the vertical reaction force (RV1) at bearing B1?
4.2. What is the horizontal reaction force (RH2) at bearing B2?
4.3. What is the total radial force (Fr1) at bearing B1?
4.4. What is the dynamic load capacity (C1) for bearing B1?
4.5. Which bearing is selected for B2 (20 mm shaft)?
4.6. What is the bearing life (L10) in million revolutions?
4.7. What load factor is applied to calculate dynamic load capacity?
4.8. What is the final bearing selection for B1 (10 mm shaft)?

1) + 6404
2) - 6000
3) - 6204
4) - 6305

30)

$$P_r = P_t \tan\alpha \qquad P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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$\tau_{max.} = 0.30\, S_{yt}$

or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

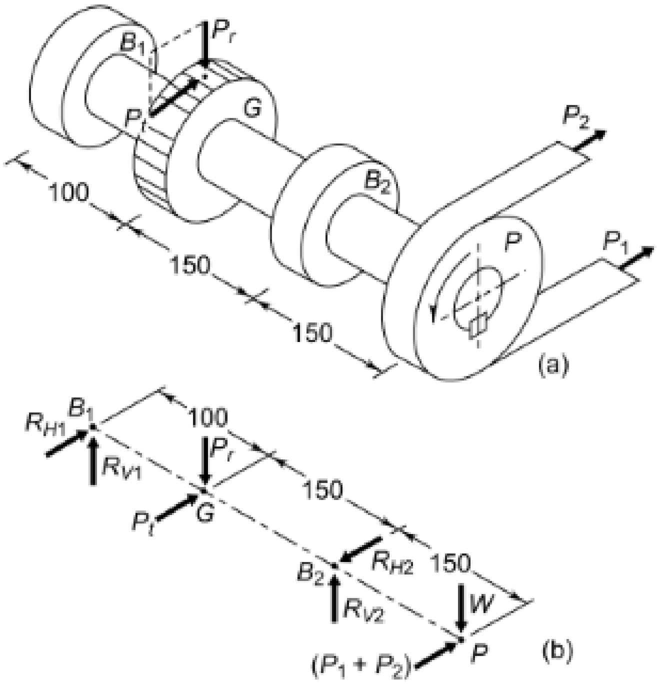
If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi\tau_{max.}}\sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404



Q4: A transmission shaft rotates at 720 rpm, transmitting power from a pulley (P) to a spur gear (G). The forces are:

• Belt tensions: P1=498 N, P2=166 N
• Gear forces: Pt=497 N, Pr=181 N
• Pulley weight: W=100 N
• Shaft diameters at bearings B1 and B2: 10 mm and 20 mm
• Load factor: 2.5
• Required bearing life (L10h): 8000 hours

Answer (Q 4.6)

4.1. What is the vertical reaction force (RV1) at bearing B1?
4.2. What is the horizontal reaction force (RH2) at bearing B2?
4.3. What is the total radial force (Fr1) at bearing B1?
4.4. What is the dynamic load capacity (C1) for bearing B1?
4.5. Which bearing is selected for B2 (20 mm shaft)?
4.6. What is the bearing life (L10) in million revolutions?
4.7. What load factor is applied to calculate dynamic load capacity?
4.8. What is the final bearing selection for B1 (10 mm shaft)?

1)	+	345.6
2)	-	8000
3)	-	720
4)	-	2.5

31)

$$P_r = P_t \tan \alpha \qquad P_t = \frac{2M_t}{d'_p}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

$$L_{10} = \frac{60 \times n \times L_{10h}}{10^6}$$

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$\tau_{max.} = 0.30\, S_{yt}$

or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)

If keyways are present, the above values are to be reduced by 25 per cent. .

$$d^3 = \frac{16}{\pi \tau_{max.}} \sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
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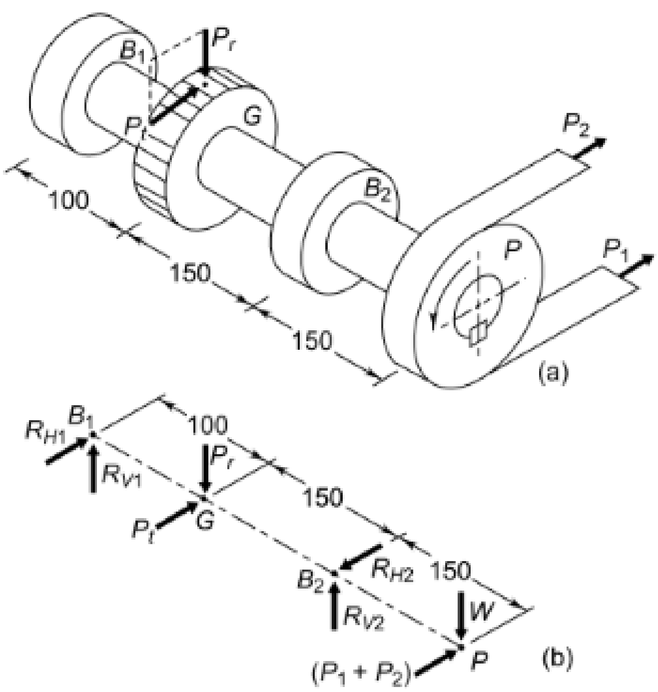

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• Gear forces: Pt=497 N, Pr=181 N
• Pulley weight: W=100 N
• Shaft diameters at bearings B1 and B2: 10 mm and 20 mm
• Load factor: 2.5
• Required bearing life (L10h): 8000 hours

Answer (Q 4.7)

4.1. What is the vertical reaction force (RV1) at bearing B1?
4.2. What is the horizontal reaction force (RH2) at bearing B2?

4.3. What is the total radial force (Fr1) at bearing B1?
4.4. What is the dynamic load capacity (C1) for bearing B1?
4.5. Which bearing is selected for B2 (20 mm shaft)?
4.6. What is the bearing life (L10) in million revolutions?
4.7. What load factor is applied to calculate dynamic load capacity?
4.8. What is the final bearing selection for B1 (10 mm shaft)?

1) + 2.5
2) - 3
3) - 1.5
4) - 7

32)

$P_r = P_t \tan\alpha$ $\qquad P_t = \frac{2M_t}{d'_p}$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D+d)^2}{4C}$$

$$\alpha = 180^\circ + 2\sin^{-1}\left(\frac{D+d}{2C}\right)$$

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One important approach of designing a transmission shaft is to use the ASME code. According to this code, the permissible shear stress $\tau_{max.}$ for the shaft without keyways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of the material, whichever is minimum. Therefore,
$\tau_{max.} = 0.30\, S_{yt}$
or, $\tau_{max.} = 0.18\, S_{ut}$ (whichever is minimum)
If keyways are present, the above values are to be reduced by 25 per cent.

$$d^3 = \frac{16}{\pi\tau_{max.}}\sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

$$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

$$\alpha_s = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$$

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
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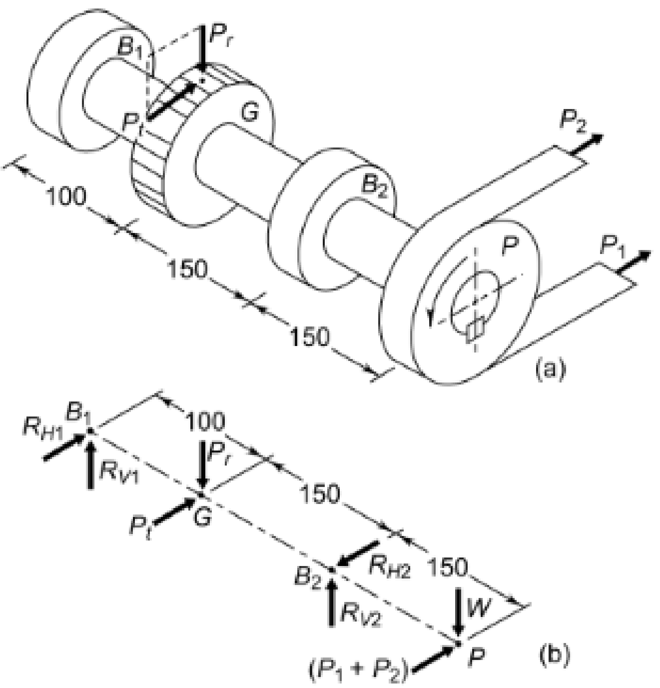
	72	19	30700	16600	6404



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- Belt tensions: P1=498 N, P2=166 N
- Gear forces: Pt=497 N, Pr=181 N
- Pulley weight: W=100 N
- Shaft diameters at bearings B1 and B2: 10 mm and 20 mm
- Load factor: 2.5
- Required bearing life (L10h): 8000 hours

Answer (Q 4.8)

4.1. What is the vertical reaction force (RV1) at bearing B1?
4.2. What is the horizontal reaction force (RH2) at bearing B2?
4.3. What is the total radial force (Fr1) at bearing B1?
4.4. What is the dynamic load capacity (C1) for bearing B1?
4.5. Which bearing is selected for B2 (20 mm shaft)?
4.6. What is the bearing life (L10) in million revolutions?
4.7. What load factor is applied to calculate dynamic load capacity?
4.8. What is the final bearing selection for B1 (10 mm shaft)?

1)	+	6000
2)	-	6404
3)	-	6200
4)	-	6300