









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 (tmax) 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) + $0.75 \times \min(0.3 \text{Syt}, 0.18 \text{Sut})$
 - 0.5×min(0.3Syt,0.18Sut)

3) - $0.75 \times \max(\text{Syt}, \text{Sut})$

2)

2)





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($20\Box$). Using the ASME code (kb=kt=1.5)

Answer (Q 1-2)

- 1-1 What is the allowable shear stress (tmax) 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)?
- + $60 \times 10^{6} \times Power/2\pi n$ 1)
- 2) Power×n×60×10⁶
- 3) $2\pi n \times 60 \times 10^{6} \times Power$

4)

Power×2πn











"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 1-3)

1-1 What is the allowable shear stress (tmax) 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



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6004

6204

6304

6404



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($20\Box$). Using the ASME code (kb=kt=1.5)

Answer (Q 1-4)

1-1 What is the allowable shear stress (Tmax) 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?





6204

6304

6404





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($20\Box$). Using the ASME code (kb=kt=1.5) Answer (Q 1-5)

1-1 What is the allowable shear stress (tmax) 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) + $Pttan(20^{\circ})$
- 2) Ptsin(20°)
- 3) $Ptcos(20^\circ)$
- 6)





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.



7)





The pulley transmits 25 kW at 500 rpm to the gear. Given: Belt tensions: P1=3P2. Gear forces: Pr=Pt x tan(20 \Box). Using the ASME code (kb=kt=1.5) Answer (Q 1-6)

- 1-1 What is the allowable shear stress (tmax) 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









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 1-7)

1-1 What is the allowable shear stress (tmax) 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) + 1,697,660 N-mm

- 2) 347,644 N-mm
- 3) 954,928 N-mm
- 4) 955,500 N-mm



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

`400

Answer (Q 1-8)

1-1 What is the allowable shear stress (tmax) 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?







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?

shaft

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







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?

shaft





- 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?
- 120 mm 1) +2)
 - 80 mm _
 - 100 mm



3)

4)





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(2-3)

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

₩ Input shaft

×

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

12)









- 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

_

13)



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

shaft





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



	ASME CO	DDE FO	R SHAF	T DESIG	N
One in shaft i code, t withou in tens the ma t, or, t, If k be red	s to use t the permis it keyway ion or 18% terial, wh max = 0.30 max = 0.18 ceyways a uced by 2	pproach of he ASM sible she s is taken S_0 of the i ichever is S_{pf} S_{af} (while re presen 5 per cen	of designin E code. A ar stress t a as 30% o ultimate to s minimum chever is n t, the abo t	ng a transm eccording t r _{man} , for the of yield str nsile stren n. Therefor ninimum) we values	ission this shaft rength gth of re, are to
	$d^{3} = -$	16	$\sqrt{(k_{s}M_{s})}$	$(k, M)^{2} + (k, M)^{2}$	$\overline{(t)^2}$
		ττ _{max.}			
L	= 2C + 2	r(D+d) 2	$+\frac{(D-d)}{4C}$	²	$\frac{P_1 - mv^2}{P_2 - mv^2} =$
	$\alpha_s = 18$	0 – 2 sin ⁻¹	$\left(\frac{D-d}{2C}\right)$		$\frac{P_1 - mv^2}{P_2 - mv^2}$

fa

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







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













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(2-7)

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



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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(2-8)

- 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?

shaft

- 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



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 3.1)

Answer (Q, 5, 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?
- $2 \neq W_{1} \neq 1 \neq 1 = 1 \quad (-1)$
- 3-4 What is the angle of wrap (in degrees)?
- 3-5 What is the exponential term $e\mu\alpha$? 3-6 What is the width of the belt?







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?







- 3-4 What is the angle of wrap (in degrees)?
- 3-5 What is the exponential term $e\mu\alpha$?
- 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

a

19)





I

1500





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 $e\mu\alpha$?
- 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)?



- 2) 4000 mm
- 3) 4500 mm

4) - 3800 mm

20)



shaft is code, the without in tensi the mat τ_n or, τ_n If ke be redu	promoting proceedings of the second proceedings of the second se
	$d^{3} = \frac{16}{\pi \tau_{\max}} \sqrt{(k_{b}M_{b})^{2} + (k_{t}M_{t})^{2}}$

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

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

F dime	Principal dimensions (mm)			load s (N)	Designation
d	D	В	С	C_{θ}	Designation
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 $e\mu\alpha$?
- 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)?
- 208.96° + 1)
- 2) 180°
- 3) 220°







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 $e\mu\alpha$?

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



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ASME CODE FOR SHAFT DESIGN
One important approach of designing a transmission haft is to use the ASME code. According to this ode, the permissible shear stress regar, for the shaft vintout keyways is taken as 30% of yield strength n tension or 18% of the ultimate tensile strength of he material, whichever is minimum. Therefore, $r_{max} = 0.30 S_p$, $r_{max} = 0.18 S_{ss}$ (whichever is minimum) If keyways are present, the above values are to e reduced by 25 per cent.
$d^{3} = \frac{16}{\pi \tau_{\max.}} \sqrt{(k_{b}M_{b})^{2} + (k_{t}M_{t})^{2}}$
$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{fa}$
$\alpha_r = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$

– F dime	Principal dimensions (mm)			load s (N)	
d	D	В	C	C ₀	Designation
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/mm^2 , 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 $e\mu\alpha$?

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



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ASME CODE FOR SHAFT DESIGN	
Due important approach of designing a transmission thaff is to use the ASME code. According to this is doe, the permissible shear arcss τ_{aux} , for the shaft without keysways is taken as 30% of yield strength in tension or 15% of the ultimate tensile strength of the material, whichever is minimum. Therefore, $\tau_{aux} = 0.38 S_{aux}$ (whichever is minimum) If keyways are present, the above values are to be reduced by 25 per cent.	
$d^{3} = \frac{16}{\pi \tau_{\max}} \sqrt{(k_{b}M_{b})^{2} + (k_{i}M_{t})^{2}}$	
$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$	
$\alpha_{r} = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right) \qquad \qquad \frac{P_{1} - mv^{2}}{P_{2} - mv^{2}} = e^{f\alpha}$	

- F dime	Principal dimensions (mm)			load s (N)	Decimation
d	D	В	С	C_{θ}	Designation
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/mm^2 , 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 $e\mu\alpha$?

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



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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 trans. 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, $\tau_{max} = 0.30 S_{sr}$ or, $\tau_{max} = 0.318 S_{sd}$ (whichever is minimum) If keyways are present, the above values are to be reduced by 25 per cent.	
$d^{3} = \frac{16}{\pi \tau_{\max}} \sqrt{(k_{b}M_{b})^{2} + (k_{i}M_{\ell})^{2}}$	
$L = 2C + \frac{\pi(D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \qquad \frac{P_l - mv^2}{P_2 - mv^2} = e^{f\alpha}$	
$\alpha_r = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$ $\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$	

Principal			Basic	load		
dime	isions	(mm)	rating	s (N)	Designation	
d	D	В	С	C_{θ}	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/mm^2 , 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 $e\mu\alpha$?

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



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В С



Designation

Basic load

ratings (N)

 C_0



10	10°	
	P_{r} G B_{2} P_{2} P_{2} P_{2} P_{1} F_{2} F_{2} F_{2} F_{2} F_{2} F_{2} F_{2} F_{2} F_{3}	
	B_2 R_{H2} 150 R_{V2} W (b)	

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?





Designation

61800

6000

6200

6300

61804

16404

6004

6204

6304

6404

- 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)

26)





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)

 $P_{-} = P_{-} \tan \alpha$ $L = 2C + rac{\pi (D+d)}{2} + rac{(D+d)^2}{4C}$ $lpha = 180^\circ + 2\sin^{-1}\left(rac{D+d}{2C}
ight)$ $L_{10}=rac{60 imes n imes L_{10h}}{10^6}$

One important approach of designing a transmission shaff is to use the ASME code. According to this code, the permissible shear stress τ_{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 _p , σ_{r} , $\tau_{max} = 0.18$ S _m (whichever is minimum) If keyways are present, the above values are to be reduced by 25 per cent.	
$d^{3} = \frac{16}{\pi \tau_{\max}} \sqrt{(k_{b}M_{b})^{2} + (k_{t}M_{t})^{2}}$	
$L = 2C + \frac{\pi (D+d)}{2} + \frac{(D-d)^2}{4C} \qquad \qquad \frac{P_1 - mv^2}{P_2 - mv^2} = e^{ra}$	
$\alpha_r = 180 - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$ $\frac{P_1 - mv^2}{P_2 - mv^2} = e^{f\alpha}$	

ASME CODE FOR SHAFT DESIGN

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







"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



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Designation

61800

6000

6200

6300

61804

16404

6004 6204

6304

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?





Designation

61800

6000

6200

6300

61804

16404

6004

6204

6304

6404

- 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)

29)





"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 4.5)

- 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)



One important ap thaft is to use the code, the permission without keyways in tension or 18% the material, whither $\tau_{max} = 0.30$ or, $\tau_{max} = 0.18$ If keyways and the reduced by 25%	pproach of designing a he ASME code. Accossible shear stress τ_{max} , s is taken as 30% of y κ of the ultimate tensil thetwer is minimum. T S_{st} (whichever is mini re present, the above y 5 per cent	transmission rding to this for the shaft ield strength le strength of herefore, mum) values are to	
$d^3 = \frac{1}{2}$	$\frac{16}{\pi \tau_{\max,}} \sqrt{(k_b M_b)^2}$	$+(k_rM_r)^2$	
$L = 2C + \frac{\pi}{2}$ $\alpha_z = 18$	$\frac{t(D+d)}{2} + \frac{(D-d)^2}{4C}$ $0 - 2\sin^{-t}\left(\frac{D-d}{2C}\right)$	$\frac{P_1 - mv^2}{P_2 - mv^2} = c$ $\frac{P_1 - mv^2}{P_2 - mv^2} = c$	$= e^{f\alpha}$

ASME CODE FOR SHAFT DESIGN

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







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



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Designation

61800

6000

6200

6300

61804

16404

6004 6204

6304

6404

 C_0

630

1960

2240

3750

1500

3400

4500

6200

7800

16600





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 4.7)

- 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)







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 4.8)
- 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