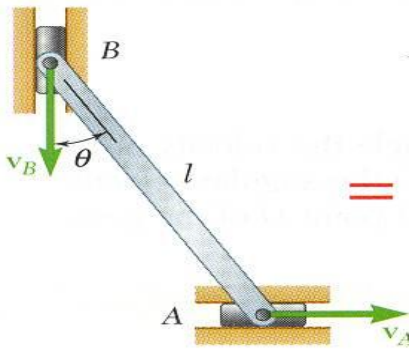
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Kinematics of Mechanisms and Robots

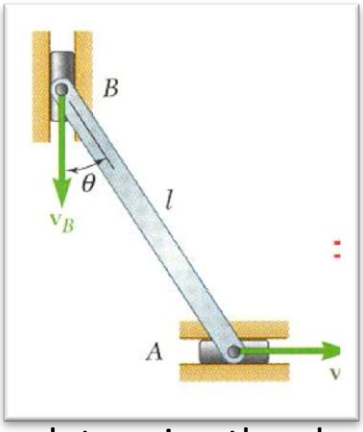
Sheet -1

1-For the shown mechanism assuming that the velocity v_A of end A is known, determine the velocity v_B of end B and the angular velocity ω in terms of v_A , l, and θ.

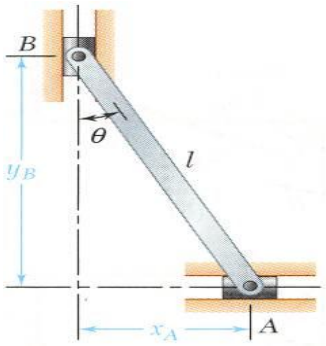


Plane motion

2-For the same problem (1) consider the reference point is B and determine the velocity vB of end B and the angular velocity w in terms of v_A , l, and θ.



3-for the shown mechanism determine the absolute velocity and acceleration of a mechanism directly.



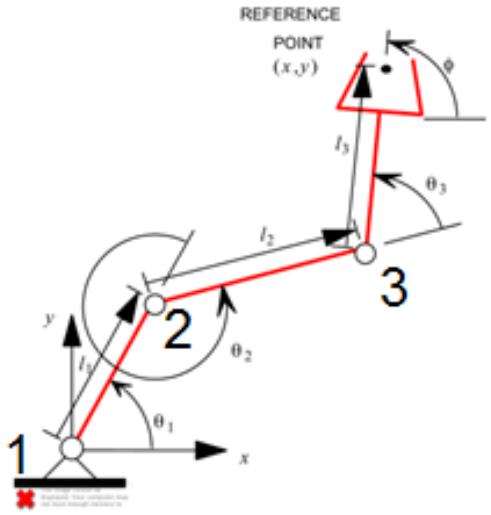
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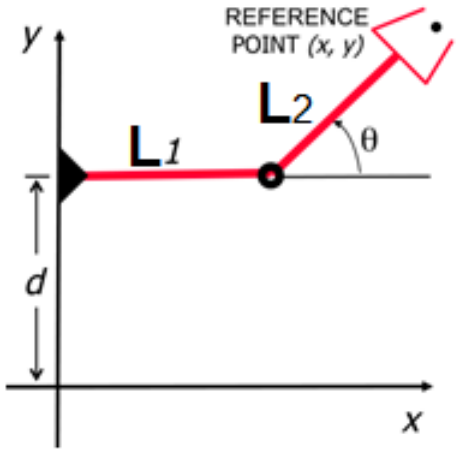
Dynamics of Mechanisms and Robots

sheet -2

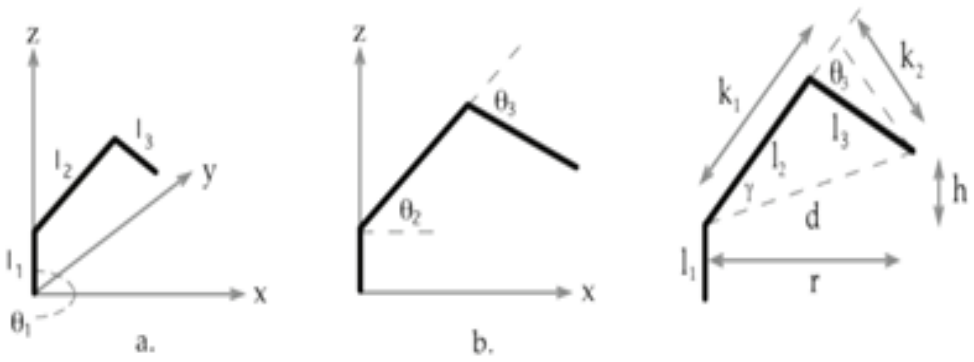
1-Determine the type of kinematics and find the position of the end effector for(x,y and Φ) , Given Θ1, Θ2and Θ3 &L1,L2and L3 ,also find the positions of the joints 1,2 and3 for given x,y and Φ.



2-For the shown sliding two link robot Determine the type of kinematics to find the position of the end effector for(x,y) , Given L1, L2 , d and Θ,also find d and Θ for given x and y.



3-For the shown three link robot Determine the type of kinematics to find the position of the end effector for(h,z) , Given L1, L2 , L3 and Θ1=90, Θ2and Θ3, also find the positions of the joints 2 and3(Θ2and Θ3) for given h,z .



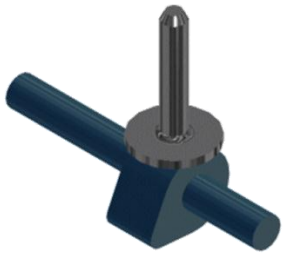
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Kinamatics of Mechanisms and Robots

sheet -3

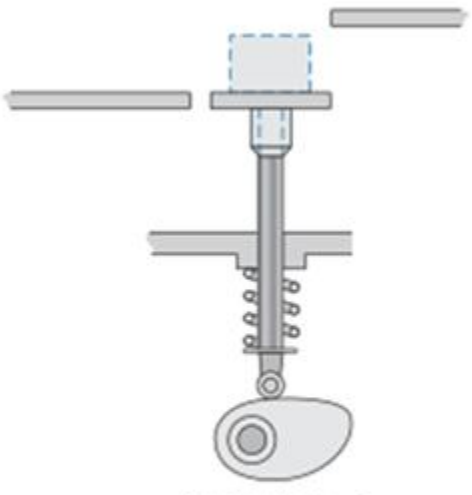
1-Design a disc cam (for use with a flat follower) such that the fig.:



- follower height is L1=2cm. when cam angle is 0°
- follower height is L2=3cm. when cam angle is α=120^{o}.
- the relationship between the height, L, and the cam angle, θ, is linear

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2-A cam is to be used for a platform that will repeatedly lift boxes from a lower conveyor to an upper conveyor. This machine is shown in Figure Plot a displacement diagram and determine the required speed of the cam when the follower motion sequence is as follows:

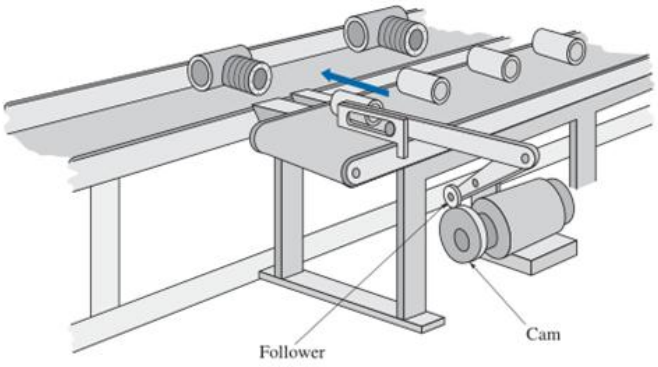


Cam system

1. Rise 2 in. in 1.2 s.
2. Dwell for 0.3 s.
3. Fall 1 in. in 0.9 s.
4. Dwell 0.6 s.
5. Fall 1 in. in 0.9 s.

3- A cam is to be designed for an automated part loader as shown in Figure .. Using the motion equations, construct a chart that tabulates follower displacement versus time and cam rotation. Also plot this data when the prescribed motion for this application is as follows:

1. Rise 50 mm in 1.5 s using the constant velocity motion scheme.
2. Return in 2.0 s using the cycloidal motion scheme.
3. Dwell for 0.75 s.
4. Repeat the sequence.



Part loader

4-For the application presented in Example Problem 3 , graphically construct a follower displacement diagram.

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Kinamatics of Mechanisms and Robots

sheet -4

1 - A 20° full-depth, involute spur gear with 35 teeth has a diametral pitch of 10. Determine the diameter of the pitch circle, the circular pitch, and the base circle.

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2 - Consider the 20° full-depth, involute spur gear, with 35 teeth and a diametral pitch of 10, from Problem 1. Determine the diameter of the addendum circle, dedendum circle, and the clearance. **Given table.1)**

STANDARD GEARS

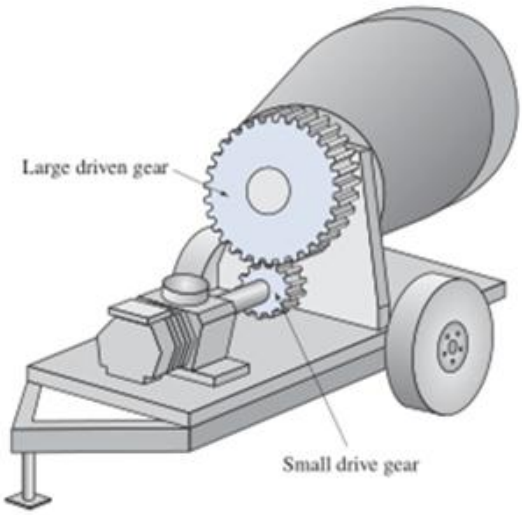
AGMA Full-Depth Gear Tooth Specifications

Tooth Feature Pressure angle, ϕ	Coarse Pitch ($P_d < 20$) 14½° or 20° or 25°	Fine Pitch ($P_d \geq 20$) 20°
Addendum, a	$\frac{1.000}{P_d}$	$\frac{1.000}{P_d}$
Dedendum, b	$\frac{1.250}{P_d}$	$0.002 + \frac{1.2}{P_d}$
Working depth, h_k	$\frac{2.000}{P_d}$	$\frac{2.000}{P_d}$
Whole depth, h_t	$\frac{2.250}{P_d}$	$0.002 + \frac{2.200}{P_d}$
Circular tooth thickness, t	$\frac{1.571}{P_d}$	$\frac{1.571}{P_d}$
Fillet radius, r_f	$\frac{0.300}{P_d}$	not standardized
Min. clearance, c	$\frac{0.250}{P_d}$	$0.002 + \frac{0.200}{P_d}$
Clearance (ground tooth), c	$\frac{0.350}{P_d}$	$0.002 + \frac{0.350}{P_d}$
Min top land width	$\frac{0.250}{P_d}$	not standardized
AGMA standard	201.02	207.04
Face width	$\frac{12}{P_d}$	$\frac{12}{P_d}$

Table-1.

---

3 - Two 5-pitch, 20° full-depth gears are used on a small construction site concrete mixer. The gears transmit power from a small engine to the mixing drum. This machine is shown in Figure The pinion has 15 teeth and the gear has 30 teeth. Determine the center distance.

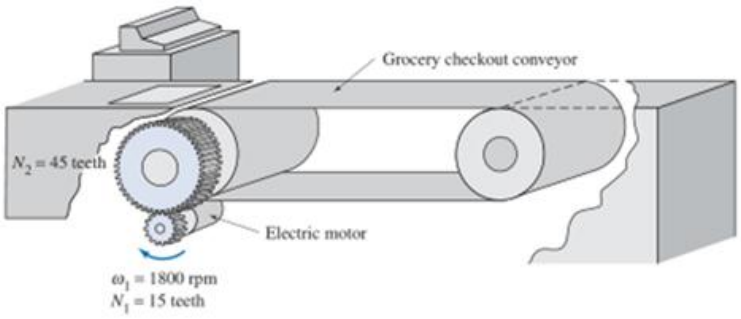


Concrete mixer

4 - For the concrete mixer gears described in Example Problem 3 , determine the contact ratio.

5 The gears for the concrete mixer described in Example Problem .3 are catalog items with a designed backlash of $0.4/P_d$. Specify a center distance that reduces the backlash to recommended value of $0.1/P_d$.

6 -A set of gears is used to reduce the speed from an electric motor to a shaft driving a grocery checkout conveyor (Figure) . The gear on the motor shaft is a 10-pitch pinion, has 15 teeth, and drives at 1800 rpm clockwise. Determine the speed of the mating gear, which has 45 teeth. Also calculate the pitch line velocity.



Checkout conveyor

7 - A gear reducer is used on a concept for a small trolling motor for fishing boats. The gears must transmit 5 hp from an electric motor at 900 rpm to the propeller at 320 rpm. Select a set of gears to accomplish this task. **(given tables -2,3)**

Recommended AGMA Gear Quality

Pitch Line Speed (ft/min, fpm)	Suggested Gear Quality (AGMA Rating)
0–800	6–8
800–2000	8–10
2000–4000	10–12
Over 4000	12–14

Table-3

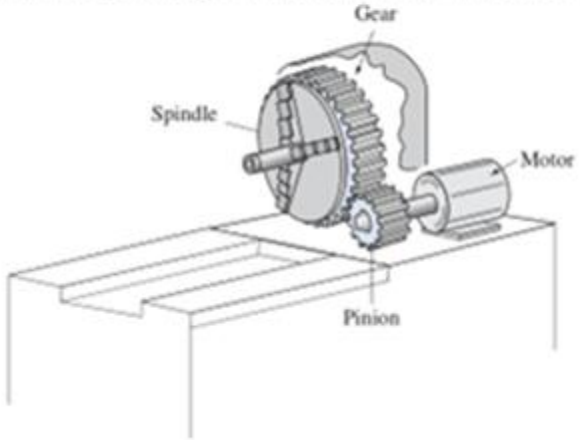
Suitable Diametral Pitches for 20° Mild-Steel Gears with Standard Face Width

Power	Pinion rpm								
hp	50	100	300	600	900	1200	1800	2400	3600
0.05	20	20	24	32	32	32	32	32	32
0.10	16	20	20	24	24	24	32	32	32
0.25	12	16	20	20	24	24	24	24	24
0.33	10	12	16	20	20	24	24	24	24
0.50	10	12	16	20	20	20	20	24	24
0.75	8	10	12	16	16	20	20	20	20
1.0	6	10	12	16	16	16	20	20	20
1.5	6	8	12	12	16	16	16	16	20
2.0	6	6	10	12	12	12	16	16	16
3.0	5	6	8	10	12	12	12	12	16
5.0	4	5	6	8	10	10	12	12	12
7.5	4	5	6	8	8	8	10	10	10
10	3	4	6	6	6	8	8	8	10
15	2	4	5	6	6	6	6	6	8
20	2	3	4	5	6	6	6	6	—
25	—	3	4	5	5	5	6	5	—
30	—	2	4	4	5	5	5	—	—
40	—	2	3	4	4	—	—	—	—
50	—	—	3	4	4	—	—	—	—

Tabled-2

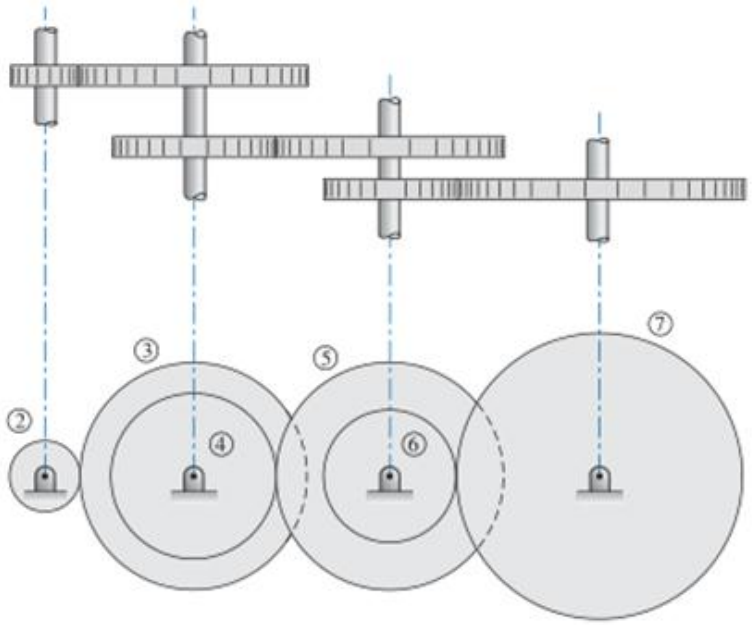
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8 A pair of gears is powered by an electric motor and used to drive the spindle of a lathe at 200 rpm. This drive system is illustrated in Figure The 1-hp motor will be replaced by a more efficient but higher-speed motor, rated at 600 rpm. To accomplish this alteration, a new set of gears must be selected that will maintain the spindle speed at 200 rpm. However, the gears are mounted in an elaborate housing that cannot be modified. Therefore, the center distance between the gears must remain at 7.5 in. Specify a set of gears that can be used. **(given tables 2,3)**



Lathe drive

9 A gear train is shown in Figure . The gears have the following properties:

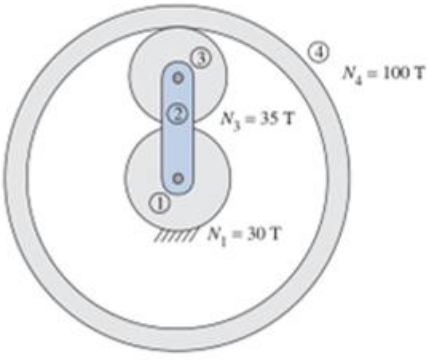


Gear train

Determine the rotational velocity of gear 7 as gear 2 drives at 1800 rpm counterclockwise. Also determine the distance between the shafts that carry gears 2 and 7.

---

10 - A planetary gear train is illustrated in Figure The carrier (link 2) serves as the input to the train. The sun (gear 1) is the fixed gear and has 30 teeth. The planet gear (gear 3) has 35 teeth. The ring gear serves as the output from the train and has 100 teeth. Determine the rotational velocity of all members of this gear train when the input shaft rotates at 1200 rpm clockwise.



A planetary gear train

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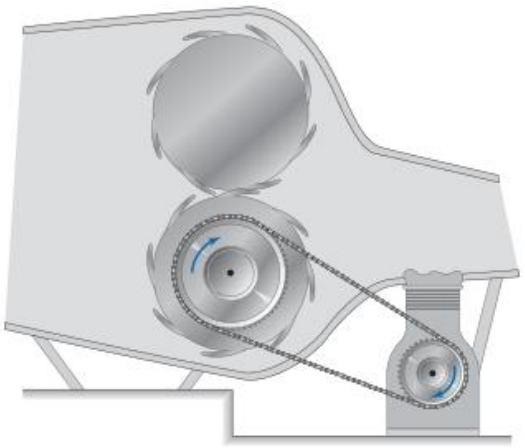
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Kinematics of Mechanisms and Robots

sheet -5

2. A single-strand roller chain drive connects a 10-hp engine to a lawn waste chipper/shredder, as shown in Figure As the engine operates at 1200 rpm, the shredding teeth should rotate at 240 rpm. The drive sprocket has 18 teeth. Determine an appropriate pitch for the chain, the number of teeth on the driven sprocket, the pitch diameters of both sprockets, and the chain speed. Also indicate the number of links in a suitable chain and specify the required center distance.

1- A belt drive is used to transmit power from an electric motor to a compressor for a refrigerated truck. The compressor must still operate when the truck is parked and the engine is not running. The 10-hp electric motor is rated at 3550 rpm, and the motor sheave diameter is 5 in. The compressor sheave has 7.5 in. diameter. Determine the appropriate industrial belt size, the operating speed of the compressor, and the belt speed. **(using 3-v Belt)**



Chipper/shredder

(given table -1)

Commercially Available Single-Strand Sprockets

Chain Size	Number of Teeth on the Sprocket
25	8 through 30, 32, 34, 35, 36, 40, 42, 45, 48, 54, 60, 64, 65, 70, 72, 76, 80, 84, 90, 95, 96, 102, 112, 120
35	4 through 45, 48, 52, 54, 60, 64, 65, 68, 70, 72, 76, 80, 84, 90, 95, 96, 102, 112, 120
40	8 through 60, 64, 65, 68, 70, 72, 76, 80, 84, 90, 95, 96, 102, 112, 120
50	8 through 60, 64, 65, 68, 70, 72, 76, 80, 84, 90, 95, 96, 102, 112, 120
60	8 through 60, 62, 63, 64, 65, 66, 67, 68, 70, 72, 76, 80, 84, 90, 95, 96, 102, 112, 120
80	8 through 60, 64, 65, 68, 70, 72, 76, 78, 80, 84, 90, 95, 96, 102, 112, 120
100	8 through 60, 64, 65, 67, 68, 70, 72, 74, 76, 80, 84, 90, 95, 96, 102, 112, 120
120	9 through 45, 46, 48, 50, 52, 54, 55, 57, 60, 64, 65, 67, 68, 70, 72, 76, 80, 84, 90, 96, 102, 112, 120
140	9 through 28, 30, 31, 32, 33, 34, 35, 36, 37, 39, 40, 42, 43, 45, 48, 54, 60, 64, 65, 68, 70, 72, 76, 80, 84, 96
160	8 through 30, 32 through 36, 38, 40, 45, 46, 50, 52, 53, 54, 56, 57, 60, 62, 63, 64, 65, 66, 68, 70, 72, 73, 80, 84, 96
180	13 through 25, 28, 35, 39, 40, 45, 54, 60
200	9 through 30, 32, 33, 35, 36, 39, 40, 42, 44, 45, 48, 50, 51, 54, 56, 58, 59, 60, 63, 64, 65, 68, 70, 72
240	9 through 30, 32, 35, 36, 40, 44, 45, 48, 52, 54, 60