



# GEARS

## Industrial Gearing Training Course

REVISED EDITION

Classroom

0506

Reprinted 2005

Copyright © Salem Company, 1991

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher.

Printed in the United States of America.

---

### **Salem Company**

Post Office Box 306  
Woodstown, New Jersey 08098  
[www.salemcompany.com](http://www.salemcompany.com)

### **Training Courses**

Phone: (856) 769-0056  
Fax: (856) 769-2048  
[sally@salemcompany.com](mailto:sally@salemcompany.com)

## Instructions to Student

You can learn this subject . . . and it's not hard.

Even if you're not mechanically inclined, or if you were never good at math, or if you disliked science subjects in school . . . you can still learn from this course.

What you learn here will be yours forever. No one can take it from you. It will make you forever after a little more knowledgeable, a little more confident, a little more capable.

Taking this course can be fun . . . Don't rush yourself, and don't worry about getting a wrong answer on the study questions.

Start at page 1 and work forward page by page. Take your time. Read **slowly** and carefully.

### **Speed is not helpful.**

Write answers to all study questions in the space provided. If you don't know the answer, make your best guess. You will need a pocket calculator for some questions.

The study questions in each section are to help you learn, not to measure or prove how smart you are. One of the great teachers of ancient times, the Greek philosopher Socrates, taught by simply asking his pupils one question after another.

Questions make you think, and thinking makes you learn. Furthermore, getting the wrong answer is as useful as being correct, provided you think through the answer yourself. Drawings or sketches can be done freehand. Just be as neat and careful as you can.

The course is divided into sections for convenience, but you can schedule study time to suit yourself. You don't have to finish any certain number of pages at each sitting.

We would like to hear your questions, comments or criticisms about the course. Please let us know by mail, phone, e-mail or fax.

Thank you for using our course. We hope you will find it interesting, useful, enlightening, and fun.

## Instructions to Supervisor

You do not have to spend your valuable time teaching elementary subjects, definitions, trade practices, and basic methods.

This course will do it for you.

It is a beginners course for anyone wanting to become familiar with industrial gearing practices in the United States. It should be useful to sales persons, drafters, buyers, machinists, assemblers, supervisors, office workers, advertising managers and others. The course is for complete beginners in the gear industry. Others may profit from it, but it is not for advanced gear designers.

The course includes eight sections, a final test, an answer book, and final test answers.

To learn from this course a student needs to know only a little high school math and be able to read carefully. The course requires very little supervision. A student should be able to work on his or her own.

Do not rush a student. Let him or her work slowly and carefully at a desk or table with good light, a pencil, eraser, scratch paper, a pocket calculator, and time enough to work slowly. Time can be scheduled as you wish. A student does not have to finish any certain number of pages at each sitting.

Study question answers and final test answers are in separate books. You can grade a student's answers yourself to measure what he's learned, or let him do it.

The study questions in each section should be answered by the student as she proceeds through the course.

We would like to hear your questions, comments or criticisms about the course. Please let us know by mail, phone, e-mail or fax.

# Contents

Instructions to Student .....	2		
Instructions to Supervisor .....	3		
<b>1. Gear Drawings .....</b>	<b>7</b>		
Gaspard Monge .....	7		
Teeth .....	8		
Spur Gears .....	8		
Sections .....	8		
Bevel Gears .....	8		
Worm Gearing .....	9		
Section Summary .....	11		
<b>2. Gear Ratios and Structures .....</b>	<b>13</b>		
Henri deVick .....	13		
Gear Ratios .....	13		
Ratios as Fractions .....	14		
Direction of Rotation .....	16		
Speed of Rotation, RPM .....	17		
Speed Ratios .....	17		
Fractions .....	18		
Gear Parts and Structure .....	20		
Outside Diameter .....	20		
Face .....	21		
Hub .....	21		
A, B and C Hubs .....	21		
Key and Keyway .....	22		
Set Screw .....	22		
Dimensions .....	22		
Keyway Size .....	23		
Plain, Webbed and Spoked .....	24		
Webbed Gears .....	24		
Spokes .....	24		
Ring Gears .....	25		
Integral Pinions .....	25		
Surface Finish .....	26		
Section Summary .....	26		
		<b>3. Gear Teeth .....</b>	<b>27</b>
		George Grant .....	27
		Gears in Mesh .....	27
		Speed Ratio .....	27
		Center Distance .....	28
		Pitch Circle .....	28
		Pitch Diameter .....	29
		Pitch Radius .....	30
		Parts of Gear Teeth .....	32
		Addendum .....	32
		Dedendum .....	32
		Clearance .....	32
		Circular Pitch .....	32
		Pressure Angle .....	33
		Tooth Thickness .....	33
		Whole Depth .....	33
		Diametral Pitch .....	34
		Tooth Parts .....	35
		Addendum .....	35
		Dedendum .....	35
		Whole Depth .....	36
		C.P. to D.P. ....	36
		Pressure Angle .....	36
		Stub Teeth .....	39
		Metric Gears .....	40
		Module .....	41
		Module and Diametral Pitch .....	42
		Module Addendum .....	42
		Module Clearance .....	42
		Module Whole Depth .....	42
		Fine Pitch Gears .....	43
		Splines .....	43
		SAE Splines .....	43
		Involute Splines .....	44
		Backlash .....	45
		Section Summary .....	46

<b>4. Worm Gearing</b> .....	<b>47</b>	<b>7. Materials and More</b> .....	<b>75</b>
Heron of Alexandria .....	47	Abraham Darby .....	75
Worm Gearing .....	47	Cast Iron .....	76
Worms .....	47	Steel .....	76
Worm Gear .....	48	Heat Treating .....	77
Thread .....	48	Stainless Steel .....	78
Double Threads .....	49	Non-Metallic Gears .....	78
Lead Angle .....	50	Gear Rack .....	78
Worm Gears .....	51	Internal Gears .....	79
Left and Right Hand .....	52	Herringbone Gears .....	80
Bronze Worm Gears .....	54	Sprockets .....	80
Back Driving .....	54	Chain .....	80
Self Locking .....	55	Section Summary .....	83
Section Summary .....	56	<b>8. Torque</b> .....	<b>85</b>
<b>5. Bevel Gears</b> .....	<b>57</b>	Archimedes .....	85
Mills .....	57	Force .....	85
Bevel Gears .....	57	Weight .....	86
Pitch Cones .....	59	Net Forces .....	87
Bevel Teeth .....	62	Reaction Forces .....	88
Miter Gears .....	62	Sum of Forces .....	89
Mounting Distance .....	63	Torque .....	90
Backing .....	63	Torque .....	95
Section Summary .....	66	Gear Torque .....	95
<b>6. Helical Gears</b> .....	<b>67</b>	Gear Torque .....	97
James Watt .....	67	Torque Multiplication .....	97
Helical Gears .....	67	Torque Ratio .....	98
Helix Angle .....	68	Power .....	100
Normal Pitch .....	69	Horsepower .....	100
Spiral Bevel Gears .....	73	Horsepower and Speed .....	103
Section Summary .....	74	Efficiency .....	104
		Section Summary .....	107
		<b>Final Test</b> .....	<b>109</b>
		<b>Index</b> .....	<b>121</b>

