

The Bike Lab

The following pages describe in detail a series of laboratory sessions for disassembling and reassembling a bicycle. Students work in teams of two per bicycle. The main objectives of these sessions are to give students

- exposure to a number of the basic “building blocks” of mechanical design in the context of a design of which they are likely to be users,
- experience actually working with these “building blocks”, and
- exposure to the ideas of features and functions in a design.

Necessary Equipment: to be supplied by instructors

How to use this document: There are three parts to this experience; namely, actual sessions working with the bicycles, reading assignments, and homework assignments. All are set up to support one another, and are summarized in the table below.

LOG Books: Each group member is required to maintain a log book. In this log you should put pictures, sketches, size of bolts/washers associated with a particular subsystem, movement descriptions, size and type of tools used, hints on re-assembly, a large dose of bike grease, any other things that would aid in the bike’s disassembly (and re-assembly) ***AND the answers to the questions associated with each Bike Lab. Individual log books and final condition of your lab bike are the main contributors to your grade on the Bike Lab. We expect bikes to be returned in better condition than when they were distributed.***

This log book is to be turned in on November 5, 1993.

OUTLINE VIEW OF THE BIKE LAB

Lab # (date)	Topic	Relevant Reading in <i>Complete Guide</i> *	Objective
Disassembly			
Bike Lab 0 (10/11)	Bike assignments and stand assembly, Log books	1,2, 3(pg. 28-47), & (bike articles in course reader)	use in recording all work
Bike Lab 1 (10/13)	Rear Brake Gears/Gearing	12 16	disassemble, clean calculations relative to bike
Bike Lab 2 (10/15)	Gear shifters Chain	8 7	disassemble, clean disassemble, clean
Bike Lab 3 (10/18)	Rear Derailleur Freewheel Rear Hub	10 6 4	removal from bike, clean removal from bike, clean disassemble, clean, reassemble
Reassembly			
Bike Lab 4 (10/25)	Rear Derailleur Freewheel Chain		re-install reassemble on bike
Bike Lab 5 (10/27)	Gear Shifters		reassemble on bike, tune shifting
Bike Lab 6 (11/1)	Rear Brake Reflections		reassemble on bike, tune,

* Complete reading before coming to class.

Bike Lab 0

Readings:

Chapter 1 (Home Bicycle Repair)
Chapter 2 (Frames)
Chapter 3 (28-47)
Bike Articles in Course Reader

Objectives:

1. Assignment of lab partners, tool boxes and lab bike
2. Assembly of bike stand
3. Initial set of bike questions.

Questions:

1. (a) On "your" bike*, what is the distribution of the rider's weight on the front and rear tires?

(b) How much does your bike weigh?
2. Which brake (front or rear) does most of the braking? Why?
3. (a) When the brakes are applied (either front or rear), is weight transferred onto or off of the rear tire? Why?

(b) When accelerating, is weight transferred onto or off of the rear tire?
4. Describe at least two ways of applying 20 ft-lbs. of torque to a bolt that you are attempting to tighten.

*Throughout the bike-related assignments, "your" bike refers to the bike that your group is taking apart.

Bike Lab 1 Brakes and Gearing

Readings:

Chapter 12 (Brakes)
Chapter 16 (Gears/Gearing)

Objectives:

1. Diagnose, disassembly and clean rear brake system
2. Gain familiarity with transmission basics

Questions:

A. Rear Brake

BEFORE DISASSEMBLY

- 1A. Perform the brake safety test described below on your bike (could use your personal bike if you prefer). Does it pass? What is the rate of deceleration necessary to pass the test if the rate is assumed to be constant? How did this rate of deceleration compare to your normal braking in terms of "feel"?

"The U.S. Consumer Products Safety Commission requires that a rider of 150 lbs. going at 15 mph on a flat, smooth dry surface (such as a concrete roadway) with the wind velocity less than 7 mph (direction not specified) be able to stop within 15 feet of initial brake application (both brakes)."

- 1B. Perform troubleshooting on pg. 208 of *The Complete Guide* . As a result of this troubleshooting, order any necessary replacement parts.
2. What are the brake pads made out of? What is "toe-in" and why is it desirable?
 3. Make a complete sketch of the rear brake system (BEFORE disassembling it), including labeling all parts and the routing of the cable. Remember, this sketch will be an aid to you when you reassemble the system.
 4. What is the cable housing made out of? How does the braking system accommodate cable stretch? Why do the brake shoes move away from the rims with cable stretch?
 5. What sort of rear brake system is on "your" bike? Are there any springs in the rear brake system? If so, why and how many? Find an alternate brake design on one of the other bikes in class and sketch.
 6. (a) Describe the application of braking force on a center pull brake.
(b) Describe the application of braking force on a side pull brake.
(c) Which do you think is better and why?

DISASSEMBLY

7. Disassemble the rear brake system, cleaning components as described in Chapter 1, ordering any components that need replacement (use class order form). In your log book note cleaning procedures used and components ordered. Put all components in the bin provided.

(continued: **Bike Lab 1** *Brakes and Gearing*)

B. Gears / Gearing

Use "your" bike installed on the bike stand to answer the following questions:

1. Describe the "flow" of power through a bike from the point where your foot touches the pedal.

2. (a) When you are pedaling, which of the following components move at the same rotational speed:

pedal
cranks
bottom bracket
chainwheel
chain
rear sprocket
rear wheel and tire assembly
front wheel and tire assembly

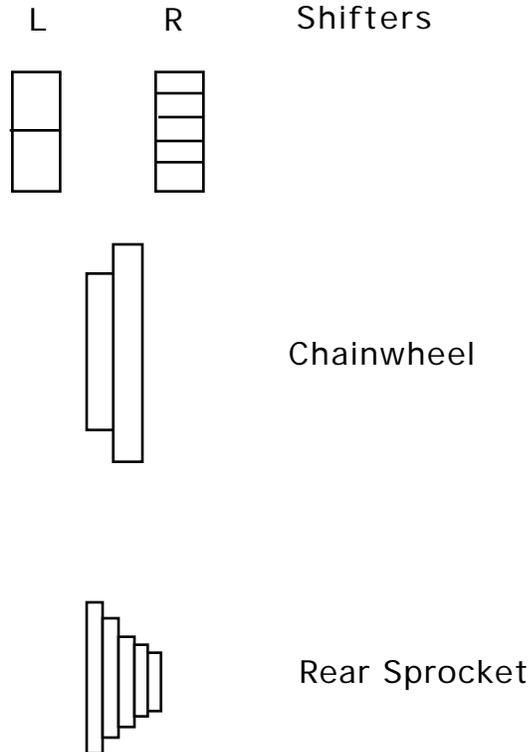
(b) When coasting (i.e., not pedaling), which of the following components move at the same rotational speed:

pedal
cranks
bottom bracket
chainwheel
chain
rear sprocket
rear wheel and tire assembly

3. Do all of the gear ratios work on "your" bike (i.e., troubleshoot the gearing system; how well does it shift?) In low gear, which chain sprocket is attached to which rear sprocket? In high gear which chain sprocket is attached to which rear sprocket?

(continued: **Bike Lab 1** *Brakes and Gearing*)

4. Diagram the relationship between the two shifters, the chainwheel, and the rear sprocket using sketches. A sample sketch is shown below. Also mark the number of teeth and diameter of each sprocket, and estimate the chain angle.



5. What is the diameter of the rear tire on "your" bike? What are the advantages/disadvantages of having a smaller size tire (e.g., 20 ")?
6. (a) Calculate the gear ratios on "your" bike.
(b) What pattern of shifting do you think would be most efficient?
7. (MM)* What effect would increasing the size of each of the following have on (a) output force and (b) output speed
- 1) front chain ring (number of teeth)
 - 2) rear cog (number of teeth)
 - 3) rear wheel (diameter)
 - 4) crank arm (length)
8. (MM)* For your bike, what output (propulsion) force would result from a 120 pound input force? (assume a gear ratio of 1.5).
9. (MM)* For your bike, what gear ratio would be required to give an output speed of 12 mph with an input pedal rate of 40 rpm?

10. (MM)* Design a bike to do the following: You want to travel 15 mph on level ground with a maximum input force equal to that of your body weight. Design a possible gearing combination. Indicate the amount of power that your body will be required to supply (is it a realistic amount?). Also, state all assumptions that you are making in performing the calculations.

*Multimedia piece on Bicycle may aid in these calculations. Show assumptions and relevant equations/calculations for each question.

Bike Lab 2 Gear Shift Levers and Chain

Readings:

Chapter 8 (Gear Shift Levers)
Chapter 7 (Chain)

Objectives:

1. Diagnose problems, disassemble and clean rear sprocket shifter
2. Gain familiarity with chain assembly.

Questions:

A. Rear Derailleur Gear Shift Lever

BEFORE DISASSEMBLY

1. Where is the shifter on "your" bike located? What are the relative merits/negatives of this location? Which, in your opinion, is the most desirable position for the shifter and why?
2. Are the shifters on "your" bike index or friction shifters? Where does the friction come into play if it is a friction shifter (i.e., between which components drawn and labeled in 3 below.)? How is the friction regulated?
3. Comment on the need for strength in the brake cable relative to the shifter cable. Which one do you think sees higher loads? What types of loads (tensile or compressive) are seen in the cable? What type of loads (tensile or compressive) are seen in the cable housing? Why is a cable used instead of a single wire?

DISASSEMBLY

4. How many parts are in the shifter for the rear derailleur? Make an "exploded" sketch and label all parts, including the interaction with the cable.
5. Disassemble the rear gear shift lever, cleaning components as described in Chapter 1, and ordering any components that need replacement (use class order form). In your log book note cleaning procedures used and components ordered. Put all components in the bin provided.
6. Explain when and why you would want a shifter with a short lever & large barrel.

B. Chain

7. Comment on the condition of "your" chain .
8. Remove the chain by pushing out the master pin (but not all the way!). How might the chain tool be improved for use?
9. How many pieces are in a single unit of the chain? Make an assembly sketch.
10. What is the pitch of the chain?
11. Clean your chain if necessary.

Bike Lab 3 Rear Derailleur, Freewheel, Rear Hub

Readings:

Chapter 10 (Rear derailleur)
Chapter 6 (Freewheel)
Chapter 4 (Rear Hub)

Objectives:

1. Diagnose problems, disassemble and clean rear derailleur, freewheel, rear hub
2. Complete overhaul of rear hub (disassembly and reassembly)
3. Gain familiarity bearings

Questions:

A. Rear Derailleur:

Remove the rear derailleur from the bike, but do not disassemble.

1. What is the job of the rear derailleur? Describe through words and sketches how it accomplishes this job.
2. In your log book note cleaning procedures used and components ordered. Put all components in the bin provided.

B. Freewheel:

Remove the freewheel from the hub, but do not disassemble

4. What is the job of the freewheel? Describe through words and sketches how it accomplishes this job. How are the rear sprockets attached to the hub (do not actually remove them)? Are the teeth on the sprockets worn? Which sprocket(s) would you expect to be more worn, and why?
5. In your log book note cleaning procedures used and components ordered. Put all components in the bin provided.

C. Hub:

Disassembly

6. How does a quick-release mechanism work? Diagrams may be the best way to show this. Can you think of another design that would accomplish the same intent?
7. (a) What type of bearings are in the rear hub of "your" bike? How many? What size?
(b) The bearings allow for movement between which components? How do you set the preload on the bearings? What are the dangers of too high or low of a preload? Are the bearings sealed?
(c) What is the recommended maintenance interval on the rear hub bearings? What sort of lubricant is recommended? What is the purpose of a lubricant?
8. What is the significance of the direction in which the freewheel turns in order to be tightened onto the rear hub?

HAVE A PICTURE TAKEN OF WHAT REMAINS OF YOUR BIKE BEFORE REBUILDING THE REAR HUB.

Bike Labs 4-6:

For all three of these labs, note in log book all lubricants used (see Chapter 1). In addition:

Lab #	Topic	Relevant Reading in <i>Complete Guide</i> *	Objective*
Reassembly			
Bike Lab 4	Rear Derailleur Freewheel Chain	10 6 7	re-install reassemble on bike
Bike Lab 5	Gear Shifters	8	reassemble on bike, tune shifting
Bike Lab 6	Rear Brake Reflections (see below)	12	reassemble on bike, tune,

Bike Lab 6 Reflections/Questions

0. Schedule session for bike check-off.
1. Sketch side and front views of a bicycle FROM MEMORY, labeling as many parts/components as you know.
2. Please comment on this lab experience. Would you rather have seen more/less:
 - instructions concerning disassembly/assembly
 - written assignments
 - lectures (if more, on what topics)
 - time allotted to the lab
 - help during open lab time
 - open lab time

How did the group experience work for you?

What role(s) did you most often end up playing in the group?

How effective were the outside speakers on bike related topics?

Plus general comments....