E-bike Repair and Maintenance
Instructional Modules
40 hours

Recommended Reading Level: ABE Level 4 and above

Module #1: General Electrical safety, E-bike electrical safety			
Objective: Provide an overview of E-bikes and safety protocols.			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 1, Day 1 2.5 Hours	**Introduction**	Getting to know E-bikes and classmates	
	Literacy, Contextualized Industry Skills, Workplace Readiness	**Collaborative Learning: EV Pair and Share(20 mins)** **Discuss Questions:** What is your experience electronics, electrical circuits, bicycles, or anything related? What is your goal in taking this class? **Watch video and complete discussion questions: (30 mins)** https://youtu.be/bSv_PkYDUqs **Reflection Question:** What experience do you have with electrical components, bicycles, or anything related **Watch Video:** **Discussion:** Did the video confirm or deny your prior experience and knowledge of safe electrical practices?	
	Assessment	**Exit Ticket (10 mins)** Check for understanding and learning with an "exit ticket". On a 3x5 card or half sheet of paper, students must write down one thing that they already knew about electrical safety and one fact that they learned that was surprising, and one thing they would like to ask in the next class	
Week 1, Day 2 2.5 Hours	**Introduction**	General Lithium Battery Safety	
	Activity	**Watch videos**	

		https://youtu.be/sWeZ5b-tPAE battery fire https://youtu.be/Egq2qzk9qRo battery fire **Discussion:** Potential dangers of lithium batteries Active Reading: https://www.consumerreports.org/health/electric-bikes/how-to-prevent-e-bike-fires-a2493889574/?msockid=255ae5243a3460de18a2f1073b786130 . **Discuss Questions: (20 mins)** What are some things you don't need to worry about when maintaining an E-bike. Why is it important to check the battery on an E-bike? What can happen if they are not checked? What are industry standards? Why is there a need for industry standards? What types of components need to be checked for industry standard? **Intro to Ebike electrical safety** When working on e-bikes, safety should be a top priority due to the combination of electrical, mechanical, and battery-related risks. Here are essential **precautions** to follow: **1. Electrical Safety** ⚡ **Power Off First** – Always turn off the e-bike and **disconnect the battery** before performing any repairs. 🔧 **Use Insulated Tools** – Avoid metal-to-metal contact with battery terminals to prevent short circuits. 🚫 **Avoid Water and Moisture** – Keep the battery and electrical connections dry to prevent shocks and malfunctions. 🛑 **Beware of High Voltage** – Some e-bike systems operate at high voltages, which can be dangerous if mishandled. **2. Battery Safety** 🔥 **Handle Lithium-Ion Batteries with Care** – Avoid puncturing or crushing the battery, as it can lead to fire or explosion. 📌 **Charge Safely** – Use only the **manufacturer's recommended charger** and avoid overcharging or charging near flammable materials. 🌡️ **Monitor Temperature** – If the battery gets too hot while in use or charging, let it cool down before handling. 🔋 **Dispose of Old Batteries Properly** – Follow local e-waste guidelines for safe disposal. **3. Mechanical Safety** 🛠️ **Secure the Bike** – Use a **repair stand** to keep the e-bike stable when working on it. 🦺 **Wear Protective Gear** – Use **gloves, safety glasses, and closed-toe shoes** to protect yourself from sharp parts and pinching hazards. 🔄 **Check Moving Parts** – Ensure the chain, brakes, and drivetrain are in good condition before testing.	

		🛠️ **Use Correct Tools** – Avoid using the wrong-sized tools, as they can strip bolts or cause improper assembly. **4. General Safety** 🧯 **Keep a Fire Extinguisher Nearby** – Especially when working on batteries or electrical components. 🛑 **Test in a Safe Area** – After repairs, test the e-bike in a controlled, open space, away from traffic. 📖 **Follow Manufacturer Guidelines** – Always refer to the manufacturer's manual for specific repair and safety instruction	
	Assessment	**15 Question review for Module 1 (15 mins)** What are best practices when working with electrical equipment? a) Power off first b) Use insulated tools c) Avoid water d) Beware of high voltage e) All the above Which of the following is NOT something you need to maintain on a lithium battery a) voltage b) storage c) temperature d) condition e) none of the above What part of the lithium battery needs to be checked regularly to ensure it is running well? a) voltage b) amperage c) ohms d) brand True or False: Any charger can be used to charge an E-bike lithium battery a) True b) False True or False: A Lithium battery can be stored in the freezer. a) True b) False True or False: A lithium battery can be stored in any environment?	

		a) True b) False Why is it important that batteries comply to International Organization for Standardization (ISO)? a) Improve quality, safety, and facilitate exchange of goods and services between countries and companies b) Provide consistent guidelines for doing something, resulting in safer and more consistent outcomes. c) Set benchmarks for businesses and consumers, ensuring reliability and building trust. d) All the above Which unit is used to measure the strength of a E-bike lithium battery? a) Volts (V) b) Amps (A) c) Kilowatts (kW) d) Joules (J) **Review answers and check for understanding (15 mins)**	

Module #2: General Safety for Bicycle Maintenance			
Objective: Understand the function of the work environment, the use of the correct tools.			
Lesson Plan			**Dates**
	Introduction	The importance of a safe work space Fire extinguisher use for lithium battery fires	
	Activities	**Safe Work Place Practice** https://youtu.be/WW0U6o1XNec taking notes on each of the 5 steps **Read**	

		https://www.indeed.com/career-advice/career-development/safety-rules-workplace ● Discuss as a class **Fire extinguisher use** https://youtu.be/GVBamXXVD30 https://youtu.be/PQV71INDaqY https://youtu.be/U478hP4oAjA Taking notes on each step: PASS method ● Discuss as a class Read https://firefighterinsider.com/the-best-fire-extinguisher-for-lithium-ion-batteries/ Discussion on basic safety procedures when working on an E-bike Discussion on use of lubricants Discussion on the use of proper tools **1. General Safety for bicycles maintenance** 🔧 **Use the Right Tools** – Always use properly sized wrenches, hex keys, and screwdrivers to avoid damaging parts. 🛠️ **Secure the Bike** – Use a bike stand or ensure the bicycle is stable before working on it to prevent tipping over. 🦺 **Wear Protective Gear** – Use gloves to protect your hands and safety glasses when working near chains, cables, or debris. **2. Mechanical Safety** 🚲 **Check for Sharp Edges** – Be cautious of chainrings, spokes, and sharp components that may cause cuts. 🔄 **Watch for Moving Parts** – Keep fingers, clothing, and tools away from rotating wheels, chains, and cranks. ⚙️ **Tighten Bolts Properly** – Avoid overtightening, which can strip threads, or under tightening, which can cause parts to loosen. **3. Brake and Wheel Safety** 🛑 **Test Brakes Before Riding** – After adjustments, always test brakes to ensure they function properly. 🔧 **Release Quick-Release Levers Carefully** – Keep your hands clear when removing wheels to avoid pinching. Check the seat quick release for proper functioning. 🔄 **Spin Wheels to Check Alignment** – Ensure wheels are true (straight) before riding. **4. Lubrication and Cleaning Safety** 💨 **Avoid Excess Lubricant** – Too much oil on the chain can attract dirt and affect performance. 🧽 **Use Proper Cleaners** – Avoid strong solvents on plastic or rubber parts, as they may degrade materials. 🔥 **Keep Lubricants Away from Flames** – Many bike lubes are flammable, so store them safely. **5. Testing and Final Checks** 🚴 **Do a Test Ride in a Safe Area** – After repairs, test the bike in a controlled space before riding in traffic. 🔎 **Double-Check Adjustments** – Ensure handlebars, seat, and	

		brakes are secure before riding. 📖 **Follow Manufacturer's Instructions** – Refer to the bike manual for torque specifications and maintenance guidelines	
	Assessment	Participatory Discussion: • Knowledge of a safe work environment • Use of fire extinguisher or lithium batteries • Use of proper tools • Lubrication safety • Bolt checks	
Week 2, Day 2 2.5 Hours	**Introduction:**	**Electrical Bike Introduction**	
	Activities	Introduction: **https://youtu.be/ui6rrsXiStg** Bike Classification: https://youtu.be/qMwm6dkIdNc E-bike Basics: https://youtu.be/zbPT2CAP3lU https://youtu.be/WlLb91xXxws	
	Assessment	**Discussion on the different components of an E-bike** Electric bicycles (e-bikes) are a modern twist on traditional bicycles, equipped with an electric motor that assists with pedaling, making cycling easier and more accessible. They are designed to help riders travel longer distances, tackle hills, and reduce the physical effort required compared to conventional bicycles. Here's a brief overview: 1. Components of an Electric Bicycle: • Electric Motor: The motor is typically located in the hub of the wheel (front or rear) or in the middle (pedal-assist motor). It provides power to assist the rider's pedaling effort. • Battery: E-bikes are powered by rechargeable lithium-ion batteries. The battery powers the motor and can usually be removed for charging. The range depends on factors like battery capacity, terrain, and rider effort. • Controller: This manages the power flow between the motor and battery, allowing the rider to adjust the level of assistance (e.g., low, medium, high). • Display: Many e-bikes feature a display that shows important information like speed, battery level, and distance traveled. 2. Types of E-Bikes: • Pedal-Assist: These are the most common type of e-bikes. The motor only activates when the rider is pedaling,	

		providing a boost to make pedaling easier. The motor cuts off once the rider stops pedaling or reaches a certain speed (usually 20–28 mph, depending on local laws). • Throttle-Controlled: This type allows the rider to control the motor with a throttle, similar to how a scooter works. Some e-bikes can be pedal-assist only, throttle-only, or a combination of both. • Speed Pedel: These are faster e-bikes that assist up to speeds of 28 mph or more, often used for commuting. 3. Benefits of E-Bikes: • Reduced Physical Effort: Ideal for people with limited physical ability or those looking to reduce the strain of biking uphill. • Eco-Friendly: E-bikes produce zero emissions while riding, making them a sustainable transportation option. • Cost-Effective: While e-bikes can be more expensive upfront than regular bikes, they offer savings on fuel and parking when used for commuting. • Health Benefits: They still provide some cardiovascular exercise while reducing the intensity, making it accessible for more people. • Convenience: E-bikes are great for long distances and tackling hilly terrain, making them a popular option for commuters or recreational riders. 4. Considerations: • Weight: E-bikes tend to be heavier than traditional bikes due to the motor and battery, which can make them harder to transport or maneuver without power. • Battery Life: The distance an e-bike can travel on a single charge depends on the motor's power, battery capacity, and riding conditions. Batteries typically last 30–70 miles per charge. • Cost: High-quality e-bikes can be quite expensive, though there are more affordable options available. Prices vary based on motor power, battery size, and additional features. 5. Regulations: • E-bikes are subject to various regulations depending on the country or region. These regulations often specify speed limits, power limits (typically 750 watts or 1 horsepower), and where they can be ridden (e.g., bike lanes, roads, etc.). In summary, electric bicycles offer an excellent blend of convenience, efficiency, and sustainability, making them a popular alternative to traditional bikes and even cars for short-distance travel. They provide a great option for eco-conscious individuals or anyone looking to enjoy cycling with a little extra assistance.	

Module #3: Introduction to Electric Bike Lithium Battery and safety			
Objective: Learn battery specification, safety considerations, safety features, battery issues			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 3, Day 1 2.5 Hours	**Introduction**	Electric Bike Lithium Battery and safety	
	Activities	I**https://youtu.be/HblXvt1Xlvw safety** **https://youtu.be/Cg21o-V8q-8 safety** **https://www.youtube.com/watch?v=MK13xFyWoaU safety** **https://youtu.be/AWd5Pu5FW98 safety**	
	Assessment	**Reflections & Questions (15 mins)** On a 3x5 card, ask students to write one thing they learned today and one question they have. Select as many questions as there is time to answer before the end of the session.	
Week 3, Day 2 2.5 Hours	**Introduction:**	Safety continued and Use of a volt meter	
	Activity	**Safety:** **https://youtu.be/AWd5Pu5FW98** **Using a Voltmeter:** https://youtu.be/HN_7eH5cMpg https://youtu.be/Obb4amLgyTw Electric bikes (E-bikes) rely on batteries to power their motors, and the most common type of battery used in e-bikes today is the **lithium-ion (Li-ion)** battery. These batteries are preferred because they are lightweight, efficient, and provide a long lifespan compared to other types of rechargeable batteries. **1. Lithium-Ion Batteries for E-Bikes** Lithium-ion batteries are a type of rechargeable battery that store electrical energy for use by the motor in an electric bike. Here's why they are ideal for e-bikes: **Key Features:** • **High Energy Density**: Lithium-ion batteries store more energy in a smaller and lighter package, allowing e-bikes to be more efficient and travel longer distances without adding excessive weight. • **Long Lifespan**: Lithium-ion batteries can typically last for several years and thousands of charge cycles, meaning they are more durable than older battery types (like lead-acid).	

		• **Faster Charging**: They charge relatively quickly, with most batteries reaching 80% of their charge in a few hours, compared to slower charging batteries used in older e-bikes. • **Lightweight**: Compared to alternatives like lead-acid batteries, lithium-ion batteries are much lighter, which helps keep the overall weight of the e-bike down. • **Higher Power Output**: Lithium-ion batteries provide more consistent power output, ensuring that the motor performs smoothly. **Battery Specifications:** • **Capacity**: Measured in **watt-hours (Wh)**, the battery's capacity determines how far you can travel on a single charge. Most e-bikes have batteries with capacities ranging from 300Wh to 750Wh, though some high-end models may go higher. • **Voltage**: This typically ranges from **36V** to **48V** and impacts how powerful the motor can be. • **Range**: On average, e-bike batteries provide a range of **30-70 miles** per charge, depending on factors such as motor power, terrain, and rider assistance level. **2. Safety Considerations for Lithium-Ion Batteries** Lithium-ion batteries are generally safe, but like all electronic devices, they need to be handled with care to prevent accidents. Here are some important safety tips and considerations: **a. Avoid Overcharging** • **Overcharging** a lithium-ion battery can lead to overheating, reducing its lifespan and potentially causing it to fail. Most modern e-bikes come with built-in protection to prevent overcharging, but it's still good practice to unplug the battery once it's fully charged. • Charging overnight is common, but make sure to follow the manufacturer's guidelines for charging times. **b. Proper Storage** • If you're storing your e-bike or battery for an extended period, store it in a **cool, dry place** away from direct sunlight or extreme temperatures. • For long-term storage, lithium-ion batteries should ideally be kept **at around 40-60% charge** to prevent deep discharge, which could damage the battery. **c. Avoid Physical Damage** • Dropping or hitting the battery can cause internal damage, which may lead to short circuits, overheating, or even fires. If you notice any dents, cracks, or bulging in the battery casing, it should be inspected and possibly replaced. • Always handle your battery with care when installing or removing it from the e-bike. **d. Avoid Extreme Temperatures** • **Cold weather** can reduce battery efficiency and range, while **high heat** can degrade the battery, causing it to lose capacity more quickly.	

		• Avoid leaving your e-bike or its battery in a hot environment, like a parked car on a sunny day, or in freezing temperatures for prolonged periods. **e. Regular Inspection** • Inspect your battery regularly for signs of wear and tear, corrosion, or other physical damage. Ensure that the battery terminals and connections are clean and free of dirt or moisture. **f. Battery Disposal** • When your battery reaches the end of its lifespan, do not throw it in regular trash. **Lithium-ion batteries** must be disposed of **properly** at designated recycling centers to avoid environmental harm and potential safety hazards (e.g., fire risks). **3. Battery Safety Features** Most modern e-bike batteries come equipped with several **safety mechanisms** to prevent accidents: • **Battery Management System (BMS)**: This system monitors the battery's voltage, temperature, and current to protect the battery from overcharging, over-discharging, and overheating. • **Thermal Protection**: Many batteries include a thermal cutoff to prevent overheating, which could lead to fires. • **Short Circuit Protection**: Built-in circuits protect the battery from short circuits, preventing sparks or fires in the event of a fault. • **Overcurrent Protection**: This feature prevents the battery from supplying too much current, reducing the risk of damaging the motor or wiring. **4. Recognizing Battery Issues** While lithium-ion batteries are generally reliable, it's important to be aware of potential issues: • **Rapid Loss of Range**: If you notice that your battery is losing its range quickly or not holding a charge, it may be time for a replacement. • **Unusual Heat**: If the battery or motor becomes abnormally hot during use, it could indicate a malfunction. • **Swelling or Leaking**: Swelling of the battery casing or leakage of fluid is a serious safety concern and requires immediate attention, usually necessitating a battery replacement. **5. Testing of Battery and charger** https://youtu.be/HN_7eH5cMpg Use of voltmeter **Conclusion** Lithium-ion batteries are the preferred choice for e-bikes due to their high energy density, long lifespan, and efficiency. However, like all high-tech devices, they must be treated with care to ensure safe operation and longevity. By following proper safety guidelines for charging, storing, and maintaining your e-bike battery, you can enjoy the benefits of electric cycling while minimizing any safety risks.	

	Assessment	**Application of Workplace Knowledge: (30 mins)** **Completeness of Report:** Did you identify at least three components of an E-bike? **Maintenance Log Plan:** Are the records accurate and clear for the next person? **Repair Referral:** Is the referral process for repair issues clear and professional?	

Module #4: Introductions to Bicycle lithium batteries			
Objective: Understanding the components of an E-bike charging system. Understand the charging process.			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 4, Day 1 2.5 Hours	**Introduction**	**Basics of Battery Charging**	
	Activities	Basics: https://youtu.be/Cg21o-V8q-8 https://youtu.be/j2fwqOfJ2mI In-depth Knowledge: https://youtu.be/x7odhPmPl8w Charging lithium-ion batteries for e-bikes is a straightforward process, but it's important to follow specific guidelines to ensure the longevity of the battery and to maintain safety. Here's a detailed guide on how to properly charge your e-bike's lithium-ion battery: **Charging Components and processes** **1.** Understanding the Charging Components • **Charger**: E-bikes come with a dedicated charger that matches the battery specifications. The charger converts AC (from your wall socket) into DC (to charge the battery). • **Battery**: The battery is typically removable and can be charged separately from the e-bike, or it can be charged while attached to the bike. **2. Charging Process** • **Step 1: Check Battery Level**	

		○ Most e-bikes have an indicator on the battery or a display on the bike that shows the current charge level. Charging when the battery is about 20-30% is a good habit to maximize battery life. Lithium-ion batteries don't have the "memory effect," so you don't need to fully discharge them before recharging. • **Step 2: Ensure the Battery and Charger Are Compatible** ○ Always use the charger that comes with the e-bike or one that's recommended by the manufacturer. Using a third-party charger that doesn't match the specifications can damage the battery or cause safety issues. ○ Verify the voltage and current ratings of both the charger and the battery to ensure compatibility. • **Step 3: Plug In the Charger** ○ First, plug the charger into the **wall outlet**. ○ Then, connect the charger to the battery. If the battery is removable, it's often more convenient to charge it separately from the e-bike, but you can also leave it attached to the bike. ○ Some chargers will have an LED light that shows the charging status. Typically, a red light indicates charging, and a green light signals that the battery is fully charged. • **Step 4: Charge the Battery** ○ Let the battery charge fully. Charging usually takes around 3-6 hours, depending on the battery's capacity (e.g., 300Wh to 750Wh). Charging times may vary. ○ **Avoid overcharging**: Once the battery reaches 100%, most chargers will stop automatically, but it's still a good idea to unplug the charger when it's fully charged to avoid overcharging, which can shorten the battery's lifespan. **3. Best Practices for Charging Lithium-Ion Batteries** • **Charge in a Cool, Dry Place**: Charge your battery in a temperature range between 32°F (0°C) and 77°F (25°C). Extreme heat or cold can degrade the battery and reduce its capacity. • **Avoid Charging to 100% All the Time**: It's actually better for the battery's longevity if you don't always charge it to 100%. Charging it to around 80-90% and recharging when it gets to about 20-30% is ideal for most lithium-ion batteries.	

		• **Don't Let the Battery Fully Discharge**: Similarly, it's not good to let the battery drop to 0%. Always try to keep the charge level above 20% to extend the battery life. • **Remove the Battery if Storing**: If you plan on storing the battery for an extended period (a few weeks or months), remove it from the bike, store it in a cool, dry place, and keep it at around 40-60% charge. This prevents deep discharge, which could damage the battery. • **Use the Original Charger**: Always use the charger that comes with your e-bike or one that is recommended by the manufacturer. Using an incompatible charger can cause damage to the battery or even present safety hazards like overheating or short-circuiting. **4. Charging Safety Tips** • **Supervise the Charging Process**: Although charging is generally safe, it's a good practice to monitor the process, especially if you're charging in a place that might not be easily accessible (e.g., overnight). • **Do Not Charge Overnight**: Charging overnight or when you're not around can be risky. It's safer to charge the battery when you're home and awake to monitor it. • **Use a Fireproof Surface**: When charging, place the battery and charger on a non-flammable, flat surface, ideally with some space around it for ventilation. A fireproof charging bag can also be a good idea as an extra precaution. • **Avoid Charging in Extreme Conditions**: Do not charge your battery in extremely hot environments (such as in direct sunlight or in a car) or very cold environments. Extreme temperatures can reduce battery performance and cause safety issues. **5. Indications of Charging Problems** If you notice any of the following issues during charging, it's a good idea to inspect the system or consult a professional: • **Overheating**: If the battery or charger becomes excessively hot during charging, unplug it and allow it to cool down. Overheating can damage the battery and may pose a fire risk. • **Unusual Noises**: A crackling or hissing noise coming from the battery or charger can indicate a malfunction. If you hear this, stop charging immediately and inspect the system. • **Battery Doesn't Charge**: If the battery isn't charging even when properly connected, check if the charger is working. If the battery still doesn't charge after trying a different charger, it might need to be replaced.	

		6. Extending Battery Lifespan • **Avoid Long-Term Storage at Full Charge**: Leaving your battery fully charged for extended periods can degrade its capacity. Store the battery at around 40-60% charge if you're not using it for a while. • **Use the Battery Regularly**: Lithium-ion batteries work best when they're used regularly. Long periods of inactivity can lead to battery degradation. • **Keep the Battery Clean**: Dust and dirt on the battery terminals can interfere with charging. Clean the terminals gently using a dry cloth if needed. **Conclusion** Charging your e-bike's lithium-ion battery is a simple process, but following proper guidelines can ensure that the battery lasts longer, performs optimally, and remains safe to use. Be sure to charge your battery in appropriate conditions, avoid overcharging, and use the original charger to get the best results. Proper care and maintenance will keep your e-bike running smoothly for many years to come!	
	Assessment	**Active Learning Assessment: (30 mins)** Students will demonstrate knowledge of components, compatibility, through active learning exercises of safely charging of battery.	
Week 4, Day 2 2.5 Hours	**Introduction:**	**Lithium Battery Storage**	
	Activities	Lithium Battery Storage: **https://youtu.be/ljQ5Tt_Ch28** **https://youtu.be/N5wCbvPgLts** **https://youtu.be/WVcFytLYOIQ** **https://youtu.be/enbZlvLbito** **Discussion of Storage of Battery** **1. Charge Level at Storage** • **Optimal Charge**: When storing your lithium-ion battery, it's best to leave it at **40-60%** charge. This range prevents the battery from degrading due to deep discharge or overcharging. Storing a battery that is either fully charged (100%) or completely drained (0%) can shorten its lifespan. • **Avoid Storing at Full Charge**: Storing a battery at 100% charge for extended periods can stress the battery and degrade its capacity over time. It's better to keep it slightly less than fully charged for long-term storage. • **Avoid Discharging Completely**: Don't let the battery discharge completely before storage, as this can cause	

		internal damage that may reduce the battery's overall performance and lifespan.
		2. Temperature Conditions
		• **Cool, Dry Place**: Lithium-ion batteries should be stored in a **cool** and **dry** environment, away from extreme temperatures. Ideal temperatures are typically between **32°F (0°C)** and **77°F (25°C)**. Extreme heat or cold can damage the battery or reduce its capacity.
		  ○ **Avoid High Heat**: Storing the battery in direct sunlight or in a hot environment (e.g., in a car on a summer day) can cause overheating, which accelerates degradation.
		  ○ **Avoid Freezing Cold**: Storing a battery in freezing temperatures can damage the cells and lead to a significant reduction in capacity.
		3. Environment
		• **Ventilation**: Store the battery in a well-ventilated area. Avoid placing it in tight, enclosed spaces that could trap heat, as excessive heat can negatively affect the battery's health.
		• **Avoid Moisture**: Keep the battery away from moisture or humidity, as this can lead to corrosion or electrical short circuits. Do not store it in areas like basements or bathrooms where humidity levels may be high.
		4. Regular Battery Maintenance During Storage
		• **Check Every Few Months**: Even though the battery is stored, it's a good idea to check it every **2-3 months**. If the charge drops below 20%, recharge it back to 40-60%. This helps to prevent the battery from becoming over-discharged, which could make it unusable.
		• **Store Battery in the E-Bike or Separately**: If you're not planning to ride the bike for a long time, you can either:
		  ○ **Store the battery on the bike**: If you leave the battery in the e-bike, make sure it's in a cool, dry place, and check it periodically.
		  ○ **Remove the battery**: If you remove the battery, make sure to store it in a safe, cool location with no risk of damage.
		5. Battery Protection
		• **Use a Storage Case or Bag**: If you're storing the battery outside of the e-bike, it's a good idea to place it in a **protective storage bag or case** designed for lithium-ion batteries. Some companies even sell fireproof storage bags for added safety.	

		• **Avoid Metal Contacts**: Never allow the battery terminals to come into contact with metal objects (such as coins, keys, or tools), as this can cause short circuits or damage. **6. Safety Considerations** • **Fire Safety**: While lithium-ion batteries are generally safe, they can be a fire hazard if damaged or improperly handled. Ensure you store your battery in a safe place, away from flammable materials, and avoid storing it in places where it might be subjected to physical damage. • **Inspect for Damage**: Before storing the battery, inspect it for any signs of damage, such as swelling, leaking, or unusual odors. If any of these issues are present, **do not store** the battery and consider replacing it. Swelling, in particular, is a sign of an issue that can cause fire risks. **7. Long-Term Storage vs. Short-Term Storage** • **Long-Term Storage**: For long-term storage (several months or more), ensure the battery is charged to about 40-60%, stored in a temperature-controlled, dry environment, and checked periodically. • **Short-Term Storage**: If you plan to store the battery for only a short period (less than a month), you can store it fully charged or partially discharged, but it's still best to keep it at around 50-60% charge. Also, avoid extreme temperatures. **8. Avoid Storing with the Battery Attached to the E-Bike for Extended Periods** • **Battery Drain**: If you leave the battery attached to the e-bike and it's not being used, it may slowly drain over time. Even though the battery management system (BMS) protects it, it's better to remove the battery if you're not going to use it for several weeks. **Conclusion** Proper storage of your e-bike's lithium-ion battery is essential for maintaining its performance and lifespan. By following these guidelines—charging it to 40-60%, storing it in a cool and dry place, and checking it periodically—you'll help ensure that your battery stays in good condition and provides reliable performance when you're ready to ride again.	
	Assessment	Demonstrate knowledge of charging and storage of E-bike lithium battery pack through written assignment.	

Module #5: Motor Types and Charging Components			
Objective: Learn the different motor styles available and the pros and cons of each.			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**

Week 2, Day 1
2.5 Hours
	Introduction	**E-bike motors come in several types, each with different performance characteristics. Here are the main types:**
		https://www.youtube.com/watch?v=LUqDtQRHTz8
		https://youtu.be/dgTtHREQA0g
		https://youtu.be/kAgcldeWjHE
		
		1. Hub Motors
		Hub motors are integrated into the wheel hub and can be located in the front or rear wheel.
		• Front Hub Motors
		  ○ Less common, often found in conversion kits.
		  ○ Provide a "pulling" sensation.
		  ○ Can affect steering balance.
		• Rear Hub Motors
		  ○ More common, providing a "pushing" sensation similar to traditional bicycles.
		  ○ Better traction and stability.
		  ○ Can be harder to service if the wheel needs maintenance.
		• Direct Drive Hub Motors
		  ○ Larger and heavier, with no internal gears.
		  ○ Silent operation and regenerative braking capability.
		  ○ Less torque at low speeds, making them less efficient for hills.
		• Geared Hub Motors
		  ○ Smaller and lighter with internal planetary gears.
		  ○ More torque at lower speeds, making them better for hill climbing.
		  ○ Can wear out faster due to moving parts.
		2. Mid-Drive Motors
		• Located at the bike's bottom bracket, directly powering the crankset.
		• Provides better weight distribution and efficiency.
		• Uses the bike's gears, making it great for hills and varied terrain.
		• Requires more maintenance and can cause more drivetrain wear.
		3. Friction Drive Motors	

		• Mounted on the bike's frame or above the wheel, using a roller to drive the tire. • Lightweight and easy to install. • Less efficient, and can wear down tires quickly. Hub Motor E-bikes Hub motor E-bikes use an electric motor located in either the front or rear wheel hub to provide propulsion. They are one of the most common types of E-bike drive systems, offering a simple and relatively low-cost solution for electric-assisted riding.	
		Types of Hub Motors 1. Front Hub Motors ○ Located in the front wheel. ○ Provides an "all-wheel-drive" feel when combined with pedaling. ○ Can feel less natural due to front-wheel pull. 2. Rear Hub Motors (Most Common) ○ Located in the rear wheel for a more natural ride feel. ○ Offers better traction, especially on hills. ○ Can make rear-wheel maintenance more complicated. 3. Geared vs. Direct-Drive Hub Motors ○ Geared Hub Motors: Smaller, lighter, and more efficient. Great for city riding and moderate hills. ○ Direct-Drive Hub Motors: Larger and heavier but provide smoother, quieter operation. Better for high speeds and regenerative braking.	
		Pros of Hub Motor E-Bikes: ✅ Affordable – Less expensive than mid-drive motors. ✅ Low Maintenance – Fewer moving parts compared to mid-drive motors. ✅ Quiet & Smooth – Direct power delivery without extra wear on the drivetrain. ✅ Good for Flat Terrain – Works well for commuting and recreational riding.	
		Cons of Hub Motor E-Bikes: ❌ Less Efficient on Hills – Struggles compared to mid-drive motors on steep inclines. ❌ Heavier Rear or Front End – Affects handling and weight distribution. ❌ Limited Torque – Not as powerful as mid-drive systems for off-road or high-performance riding. ❌ Difficult Repairs – Rear hub motors make wheel maintenance more complex.	
		Mid-Drive E-Bike Motors: Mid-drive motors are located near the bottom bracket of an e-bike,	

		directly driving the crankset instead of the wheels. This design provides better weight distribution, improved efficiency, and a more natural riding feel compared to hub motors.	
		Advantages of Mid-Drive Motors: ✅ Better Weight Distribution – Centralized placement improves bike balance. ✅ Increased Torque & Efficiency – Uses the bike's gears for optimal power, making it great for hills and heavy loads. ✅ More Natural Pedaling Feel – Works in sync with pedaling, providing a smooth ride. ✅ Better Battery Efficiency – Uses energy more effectively, extending range.	
		Disadvantages of Mid-Drive Motors: ❌ More Expensive – Generally costlier than hub motors. ❌ Increased Drivetrain Wear – Chain, cassette, and derailleur experience higher stress. ❌ Requires More Maintenance – More moving parts can lead to increased wear and tear.	
		Best Use Cases for Mid-Drive Motors: 🚵 Mountain Biking (eMTB) – High torque for steep climbs. 🚲 Commuting & Touring – Smooth pedal assist and energy efficiency. □ Cargo & Utility Bikes – Strong torque for carrying heavy loads. **Friction Drive E-Bike Motors:** Friction drive motors are a simple type of e-bike motor that powers the bike by pressing a rotating roller against the tire. This method provides pedal assistance without modifying the drivetrain or wheels.	
		How It Works • A small motor with a roller is mounted on the frame (above the rear wheel or near the front wheel). • When activated, the roller spins and makes contact with the tire, propelling the bike forward through friction.	
		Advantages of Friction Drive Motors: ✅ Lightweight & Compact – Small and easy to install, making it ideal for lightweight e-bike conversions. ✅ Simple Installation – No need to change wheels or modify the bike's drivetrain. ✅ Affordable – Often cheaper than hub or mid-drive motors. ✅ Quick Detachability – Can be removed easily when not needed.	
		Disadvantages of Friction Drive Motors: ❌ Less Efficient – Some energy is lost due to slippage between the roller and tire. ❌ Limited Torque & Power – Not ideal for steep hills or high-speed riding.	

		❌ Increased Tire Wear – Constant contact with the roller can wear down the tire faster. ❌ Weather Sensitivity – Performance may drop in wet conditions due to reduced traction.	
		Best Use Cases for Friction Drive Motors: 🚲 Casual Riders & Commuters – Great for light pedal assist on flat terrain. 🔧 E-Bike Conversions – Quick and simple upgrade for a regular bike. 🏙️ Urban Use – Ideal for short trips in the city.	
	Assessment	**Discussion of the types of motor, and the pros and cons of each.**	
Week 2, Day 2 2.5 Hours	**Introduction**	**<u>Displays</u>** **Types of Handlebar Displays:** **https://youtu.be/y6JomDr6C0c** E-bike displays vary in functionality, size, and placement, depending on the type of e-bike and its features. Here are the main types: 1. Basic LED Displays • Show essential information like battery level and pedal-assist mode. • Usually have a few buttons for power and assist level adjustment. • Common on budget e-bikes and minimalist designs. 2. LCD Displays • Offer more detailed information, including speed, distance, and trip data. • Often include a backlight for visibility in low-light conditions. • Found on mid-range and high-end e-bikes. 3. TFT (Thin-Film Transistor) Color Displays • High-resolution, full-color screens with enhanced readability. • Show advanced metrics like navigation, cadence, and motor power output. • Found on premium e-bikes. 4. Touchscreen Displays • Allow for intuitive control via touch input. • Often include GPS navigation, smartphone connectivity, and app integration. • Common on high-end e-bikes with smart features. 5. Integrated Stem or Frame Displays • Built directly into the stem or frame for a sleek, modern look. • Often feature minimalistic LED or LCD screens. • Used on high-end urban and commuter e-bikes. 6. Handlebar-Mounted Smart Displays • Can connect to smartphones via Bluetooth. • Offer ride tracking, fitness data, and even turn-by-turn navigation. • Examples: Bosch Kiox, Shimano STEPS, Bafang DP-C18.	

	Assessment	Checking for Understanding (15 mins) Students will be assigned two questions on displays and provide verbal responses.	

Module #6: Central Processing Units			
Objective: Understand the functionality of the E-bike CPU			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 2, Day 1 2.5 Hours	**Introduction**	**Ohm's Law & Watt's Law - Math Principles**	
	Activities	**CPU:** **What is a CPU:** https://youtu.be/hioc8nig9zY https://auroraelectrico.com/electric-bike-controller/ ● The **CPU (Central Processing Unit) or Controller** in an e-bike is the brain of the system, managing power distribution, motor control, and sensor data processing. It determines how smoothly and efficiently the e-bike operates. **Types of E-Bike Controllers (CPUs):** ● **1. Basic Controllers (Square Wave)** ● Found in entry-level e-bikes. ● Provide simple throttle and pedal-assist functionality. ● Less efficient and can cause a jerky riding experience. **2. Sine Wave Controllers** ● Deliver smoother power output, reducing motor noise and vibrations. ● More efficient and responsive to rider input. ● Common in mid-range and high-end e-bikes. **3. FOC (Field-Oriented Control) Controllers** ● Advanced controllers that optimize motor efficiency and torque. ● Offer smoother acceleration and improved hill-climbing ability. ● Found in high-performance e-bikes.	

		4. Smart Controllers ● Integrated with Bluetooth, GPS, and smartphone apps for real-time monitoring. ● Can adjust power output based on terrain, riding style, or battery levels. ● Used in modern high-tech e-bikes. **5. Key Functions of an E-Bike CPU** ● **Power Management**: Regulates battery output to the motor. ● **Pedal Assist & Throttle Control**: Adjusts motor response based on input. ● **Sensor Processing**: Reads data from torque, cadence, and speed sensors. ● **Safety Features**: Includes overheating protection, regenerative braking, and motor cutoff when braking.	
	Assessment	Discuss the basic principles of the CPUs.	
Week 2, Day 2 2.5 Hours	**Introduction**	**Troubleshooting: Common Problems with E-bikes**	
	Assessment	**Exit Ticket & Review: (5 mins)** On a 3x5 card, students will answer the following questions before leaving class: ● Identify the types of controllers and main functions of the E-bike CPU.	

Module #7: Assembly of Drop Cycles E-bike			
Objective: Complete assembly and first test ride of Drop Ebike			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 2, Day 1 2.5 Hours	**Introduction**	**Assembly of Bicycle from a box**	
	Activities	**Assembly of the Drop Electric Rental Bike:** Bike Build **https://youtu.be/Ep8GizLoC_c** **https://youtu.be/ma_q3Phzets**	

		BIKE LOG Review the bike log. It should be readily available. The box has information on it. Some information will include the Manufacture, and the manufactures contact information. The make and model of the bike. The size of the frame of the bike. The serial number. Any shipping warnings will be printed on the other side of the box. Assembly instructions may also be printed. Tools necessary can usually be found on the box. Log information such has make, model, size, serial number, date of build, mechanic signature of the initial build, and any other information required. 1. CAREFULLY OPEN THE BOX Do not use any sharp objects. Many of the bike's parts are located under the top flaps of the box. The lid is glued closed. Sometimes staples are used as well. Remove any staples on top of the box with a pair of pliers. Gently pull the top of the box open. Fully open the other flaps. Inspect the contents for any loose items such has accessories, racks, reading materials, or loose parts 2. CARFULLY REMOVE THE BIKE FROM THE BOX. E Bikes are heavier than a non-motorized bike. It might take two people to remove the bike. If the bike is too heavy, the box can also be further opened on the sides allowing the front on the bike box to open. Be wary that parts like the front wheel may be zip tied to the frame. Grab the frame in the front, and with the other hand grab the rear wheel and remove the bike from the box. Place the bike to the side. Make sure it will not fall over. It might need to lean on a stand, or wall. 3. LOOK INSIDE BOX FOR ACCESSORIES There is almost always a parts box, and a separate charger box. Owner's manuals, and other paperwork may be on the bottom of the box has well. 4. HANDLEBARS The Drop Bicycle is shipped with the handlebars not installed and the brake cables already attached. This means the handlebar is partially attached to the frame. IT will swing upon removal. Caution needs to be taken when pulling the bike out of the box the handlebar does not kink the brake cables or scratch the frame. 5. PARTS BOX(ES) The Drop bike comes with the Front Rack, Special Tool Kit, Pedals, Front Wheel, and Charger box not on the bicycle. Locate the charger and parts box. Inside the box is the lithium battery charger, charger cords, keys, and a special too kit 6. DROP TOOL KIT The Tool Kit is Drop specific and must be used to assemble the bicycles. The Drop Tool Kit contains sperate Front and Rear hub nut tools. These tools require the use of an ½" manual ratchet. Find the tools and verify there is a smaller tool for the front hub, and a larger tool for the rear. Verify the fit on the hub axle nuts.	

		There should also be a set of ¼'' socket tools. One is for the stem quill bolt, the pedals, and the crank bolts. There should be a T20 security tool that is required to secure fender bolts, rack bolts, and needed to remove the code plate from the top of the stem. 7. BATTERY Remove the battery from the frame. To remove the battery, find the keys and insert into the lock on the right side of the down tube. Rotate the keys counterclockwise to the unlock position. Lift the battery from the frame. It is recommended to fully charge the battery before its first use. Place the battery on its charger. The charger will have a red light indicating the battery is not charged. The light will turn green when it is fully charged and can be removed from the charger. 8. SEAT POST The seat post needs to be securely tightened by the quick release lever. Ensure there is sufficient tension on the lever to prevent the post from slipping. Adjust the lever as needed with the nut on the rear of the quick release lever. Drop bicycles feature a design that will not allow it to be removed from the frame. If the seat post needs to be removed, the security bolts will need to be removed. 9. PLACE BIKE IN STAND Now place the bicycle in the stand. Adjust the stand has necessary to securely hold the seat post in place. 10. UNDRESS Carefully undress the bike from is protective wrappings. 11. STEM INSTALLTOIN https://youtu.be/yM90mfrjkUA Remove the protective wrapping from the quill of the stem. This will be inserted into the frame. Take a brush and spread grease inside the steer tube on the fork. Now insert the quill of the stem into the steer tube. There is a spacer on the quill. The spacer should rest on top of the head tube. On top of the stem is a plastic code plate that need to be removed to access the quill bolt. It used a number T15 security bit. Remove the 4 bolts that secures the plate. With the plate removed it exposes the head of the quill bolt. Find the tool that matches the quill bolt head. Use the tool that matches the quill bolt and snug the stem down. It will be torqued to factory specification after the front wheel is installed and its alignment is verified. 12. FRONT WHEEL https://youtu.be/hdjB_wHW0-Q Find the front wheel. The wheel on the Drop bicycle uses a band brake. The band brake has a long black fixing arm. This arm mates to the mount on the inside of the left for leg. The fixing arm keeps the brake mechanism from rotating. It is critical to have in located inside the mount for proper operation. Locate the Drop Front Hub nut tool.	

		Remove the hub nuts and washer from the front axle. Take the front wheel and insert the hub axle into the fork dropouts. Ensure the brake arm is inserted into the brake arm fork mount on the inside of the left fork blade. Slip the hub axle washer on both sides of the hub. Take the hub nuts and hand tighten the right and left nuts. Using the Drop Front Hub tool secure the hub nuts to factory torque specifications. Ensure the wheel is straight in the fork. The tire should be even on both sides of the fork blade. If not, loosen the hub axle nuts and repeat until the fork is even. Using the Drop Stem Bolt tool tighten the stem quill bolt to factory specs. 13. FRONT BRAKE https://youtu.be/cycB6t10Q44 The front brake cable can be installed. Insert the cable housing and barrel adjuster into the front brake cable mount on the fork. The silver pinch bolt on the end of the cable will fit perfectly into the hub cable capture. The capture will need to rotate counterclockwise while the cable pinch bolt is manipulated into place. Please refer to the rear brake for a visual reference. Once the brake cable is secure, the handlebar lever can be adjusted. Squeeze the lever and adjust the reach with the barrel adjusters on the lever and for leg. If more adjustments are required, the loosen the cable pinch bolt and pull excess cable through the pinch bolt. Tighten the pinch bolt and check the handlebar lever again. 14. REAR BRAKE Check the rear brake at this time. Squeeze the rear brake lever and adjust the travel has necessary. The rear brake adjusts like the front. Use the barrel adjuster on the lever for smaller adjustments, and the pinch bolt if necessary. 15. SECURE STEM https://youtu.be/yM90mfrjkUA With the front wheel installed now the stem can be secured. Stand with the front wheel between your legs and align the stem with the tire. Torque the stem quill bolt to factory spec. 16. REAR WHEEL https://youtu.be/QzN3ypBEDh0 Locate the Drop Rear Hub Nut Tool. Verify the rear wheel is secure. Place the tool on both the right and left nuts and check for tightness. 17. PEDALS INSTLAL https://youtu.be/LFbSBG7jMzY Locate the Drop Pedal Tool. It will be used to install or remove the pedal. It is inserted into the spindle through the rear of the crank arm. Locate the pedals. There are specific pedals for the right and left side of the bike. The pedals are marked with an L or R. The left pedal is a reverse thread. Grease the threads of the pedals. Insert into the appropriate crank arm and hand tightened. Use the Drop Pedal Tool and secure the pedals to the corresponding crank arm. 18. CRANK ARM BOLTS Locate the Drop Crank Arm Tool. Insert into the right and left crank arms bolts and verify the arms are secure to the bottom bracket. 19. BASKET AND ACCESSORIES	

		Locate the The Drop front basket. Its basket incorporates an electronic light with a connection. This connects to the female end protruding from the head tube. The basket is attached to the head tube with 4 bolts. The bolts are already installed in the frame. Remove the four bolts from the head tube. Locate the head light wire in the frame and its corresponding end on the basket. Plug the two ends together. With care not to pinch the headlight wire, install the basket to the frame with the four bolts. Tighten the bolts down taking care not to pinch the headlight wire. The basket comes with a clip board that can be installed now. Remove the four bolts on the inside of the basket and stall the clip board. 20. FINAL BOLT CHECK The bicycle is mostly built at this point. Before it is removed from the stand it is a good practice to double check all the bolts again. This process only takes a few minutes. After The Bolt Check is completed, the bicycle can be removed from the stand. 21. TEST RIDE Take the bike on a 5-minute ride. Ensure the brakes function correctly. Ensure the bike pedals smoothly. Ensure the bike accelerates smoothly. Listen for any strange sounds like rattles or grinds. 22. FINAL LOG ENTRIES After a successful test ride the bike is ready for to be put into service. Complete any necessary log entries at this time. Congratulations!	
	Assessment	**Pair and Share: (30 mins)** In pairs, ask students to discuss the steps it takes to assemble a bike. Have each student bolt check, and test ride the others work	
Week 2, Day 2 2.5 Hours	**Introduction:**	**Manuals, warranties, ordering, recalls, First Tune up**	
	Activities	**Owner's manual** The owner's manual comes with the bike. It contains useful information on the assemble of the bike. Inside the manual will usually be a step-by-step instruction with pictures, tools needed, and torque specs. The owner's manual will also have the manufacturers information inside it. In case of questions there is usually a phone or web address. If the bike has issues that are of a product nature, the owner's manual will provide warranty information. Warranty information will provide a contact. Manufactures can help with warranties, returns, replacements, upgrade, and recalls. It's a good practice to have all manufacturers contacts in one place. Quick access to contacts can solve most questions, repairs, or any other problem. Contact information should include the name of the manufacturer, contact phone number,	

		contact addresses, emails, the Inside customer service representative, the inside warranty and returns representative. The inside representatives should help with ordering, and shipping. Replacement parts or returns are usually covered by the inside warranty representative. **Warranties** Most bikes will come with a warranty on parts, and labor. The warranty is usually a few months to one year. This covers materials and workmanship. If the problem occurs on a new bike, it is usually a matter of contacting the inside representative for a replacement part. After the bike is used, it usually requires more paperwork, like date of purchase to get replacement parts. Due to the high volume of bikes produce, faulty product often goes unnoticed until the build. Some products that fail will occur at a rate that cause a recall of the product. Weather the bike is new or used, the inside representatives are a great place to start when problems occur. They answer questions on their products and will have the most knowledge of any issues. **Ordering replacement parts** To replace a part, you must first know what it is. Most bike parts have manufactures name and corresponding serial numbers attached. Some parts, like brake levers, will be mass produced with no special numbering. Knowing the make and model of the bike can help determine what parts are specified by the manufacturer. The date of manufacture is important too. Often the serial number will have this information encoded in it that the manufacturer can help decode. Serial numbers are usually found on the bottom of the bottom bracket, the head tube, or the rear drop out. Have this information readily available when speaking with the manufacturer. **Recalls** Recalls happen when a part needs to be replaced. The part can be faulty, known to fail, or is a safety issue. Failures can be in the parts, frame, or in the electrical on ebikes. A recall is sent by the manufacturer with replacement parts. Replacing the part will lead to a credit with the manufacturer in most cases. Many times, with e bikes after several failures a manufacturer will send out numerous parts for future issues.	

		Tune-Ups : **https://youtu.be/sp1SzbKxcWY** Read Article on Complete Tune-ups **https://www.rei.com/learn/expert-advice/intro-to-electric-bike-maintenance.html** Dérailleurs: **https://youtu.be/piryjIPl3NY** When a bike is brought back it need to be checked back into the rental fleet. When the bike is received the first thing to do is start the documentation process. The rental agreement should be readily available. Check the rental bike is the correct issued to the renter. Often, bike will get rented in a group and get exchanged between riders on accident. Ask the renter how the bike worked. This can often reveal problems the rental might have. Inspect the frame for any scratching or marring of materials. Inspect the wheels for trueness. To do this, just pick up the front of the bike and spin the wheel. Look for any side-to-side movement of the rim or tire. Do the same for the rear of the bike. The brakes, headset and chain are also easy to check without the bike in a stand. Squeeze each lever to insure proper adjustment. Pull the chain up and down checking it is not to tight or too loose on single speed bikes. IF the initial return inspection passes, then complete the rental paperwork. Complete your rental book log with any notes from the customer. Any repair needed should be filled out and the bike put into maintenance. If the rental bike is return in good condition, has most will be, then it can be put into service again. Now is a good time to give the bike a cleaning, put lube on the chain, and make sure the tires are properly inflated. IF the bike is new, every nut and bolt should be checked for proper tightness. Handlebars, stems, brake levers should be firmly attached without movement. Chains need to be wiped and inspected. The spokes on the wheels need to be inspected for proper tension. Air pressures need to be checked. If the general return inspection is successful and the bike will be put back into service, then Pull the battery and put it on the charger. The battery should have the same identification number has the bike it came from. This will ensure that the battery and the bike stay with	

		one another. Some e bikes will allow the battery to be charged while on the bike. I recommend a dedicated charging station for the battery by themselves. This will keep the rental space clean without a number extension cords, or power supplies laying around the work environment. The charging station should have some major considerations. One consideration is in the event of a battery failure, which may cause an explosion with fire, it needs to be free of any what to spread the fire. There need to be adequate fire suppression available. Fire extinguishers, automatic sprinklers systems and fireproof containers should be used. Flammables need to be kept at a distance from the charging area. Batteries can be placed in fireproof containers during charging. While this extra cost might sound extreme a lithium battery can cause significant damage if it fails. Although rare, In the worst case the battery can explode with extreme fire. The fire can catch on surrounding materials very quickly. IF the bike was built correctly, it should not need a complete tune-up yet, but it is a good practice to verify everything is working correctly and bolts are tight after the first rental. The first tune-up should include checking every bolt for proper tightness. All major components like the brake should be checked. Once a bike is rented a few times and checked upon return, it can go many miles between tune-ups. 3-8 rentals without a complete tune up is common. That doesn't mean a bike can be returned without inspection. All bikes need to be inspected for any safety, or mechanical issues on return. It just means a complete tune-up doesn't need to be scheduled after every rental. Log the bike in the Rental book. Date, time out, time in, mileage, customer comments, and any general note on the rental should be noted. Any damage should be noted as well. The tally of the total number of times rented needs to be updated. Any future schedule for the rental, such has a tune up, or part replacement can now be scheduled. Many occasions the renter will inform you of any issues. These issues should prompt an immediate inspection. Small adjustments or concern can usually be handled without the bike in the stand. If there are any concerns of safety, then the bike must be put in a stand and the issue(s) addressed. Once the repair is completed, it needs to be noted in the rental logbook. Notes should include the date, the issue at hand, person who brought the bike in, and the mechanics notes the repair. If the bike needs to be put out of service, it should be clearly noted on the service tag. Once repaired, the bike should	

		be put through a tune up and returned to the rental fleet. Again, any work completed should be put in the rental log for that bike. Has the new bikes season, they will have fewer issues. This is usually the case for the first year of a new bike. Has the bike got more miles, it wears, and it will need more attention. Every bike will wear differently and will require attention. Keeping logs will inform when it needs attention, if it has prior issues, and it keeps a record of the number of usages. All bikes will wear, and E-bikes will have battery life expectancies to forecast. Knowing when a bike will need to be completely replaced is a great opportunity to forecast future services, purchases, expansions, or contractions in the market	
	Assessment	In class exercise: • Find manufacturers contact information • Request an owner's manual • Start a warranty by acquiring a return authorization number, or RA number	

Module #8: Define the individual bicycle components			
Objective: Identify the name and function of bicycle components **Instructional Materials:** YouTube video, online articles			
Lesson Plan			**Dates**
Week 2, Day 1 2.5 Hours	**Introduction**	**Frame, seat posts, seats, and saddles**	
	Activities	**Bicycle Frame** https://youtu.be/QN64bP8xkLc frame basics https://youtu.be/ddQ50eiUo0Q materials A bicycle Frame consists of a top tube, down tube, head tube, seat tube, seat stays, chain stays, and the bottom bracket. The top tube goes on the top of the bike, connecting the seat tube to the head tube. The Head tube is he front vertical tube that houses the fork. The seat tube is the vertical tube in the middle of the bike the seat post is inserted to. At the bottom of the seat tube is the bottom	

		bracket. The bottom bracket house the bearings the crankset revolves around. At the top rear of the seat tube are the seat stays. These tubes connect the rear drop out for the rear wheel to the back of the seat tube. On the bottom on the frame, connecting he Bottom Bracket to the rear drop out are the chain stays. Frames will come in sizes from extra small to 2 xl. Size is usually determined by the length of the seat tube. Most modern adult bikes will have seat tubes from 13" on the extra small size, up to 24" on the axles. This is due to the differences in human bodies. A very large person should never be put on a small bike. A small person should not be put on a large bike. It will cause handling and fitting issues. A medium size person should also be put on the right size bike, but there is more room for error for an average size person. A traditional style frame is called a double diamond. It looks like two triangles put together. They typically have been used in mountain bike style frames. Some may call this style male frames verse a female frame. Female frames tend not to have a top tube on them. This allows the rider to step through the frame instead of throwing a leg over it. Thus, they are often referred to has a step through frame. This style frame will fit most people very comfortably. They tend to shorter for mounting with a shorter reach to the handlebar. You will find this frame prominent among city, cruiser, and causal style bicycles. Many e bikes will use this style frame has it tends to be user friendly. Aluminum and chromoly steel are the material of choice for many bikes. Lower to mid-level bikes will use these materials. Aluminum is light and strong. Chromoly is cheap and strong making them both great for manufacturing. Cabon fiber and titanium are excellent materials for a bicycle frame too. The main drawback is a Signiant increase in material cost, and manufacturing cost. The cost can be many times that of steel or aluminum and is reserved for expensive high-end bicycles. **Seat Post** Basic Adjustments https://www.youtube.com/watch?v=e-8G1G9QNX8 Basics: https://youtu.be/F1cSJXESSxc Dropper Post: https://youtu.be/eL51WadNdRI https://youtu.be/rD9bsKN6zx0 **Primary Concepts**: Sizes, materials, dropper, suspension, rigid, markings, head clamps, greasing, carbon balls, dimensions. The seat post is one of the most important parts of the bike. If not properly set up it will not only become dangerous, but it will affect the way the rider interacts with the bike. IT will compromise the	

		rider's ability to climb, descend, and get the most efficient position possible out of the bike. There are times when an 'inappropriate' for riding efficiently will be appropriate for the customer's needs. This topic will be covered in depth in the fitting section, but for now let's assume the customer is right if the feel of the bike is good. Meaning the seat, stem, handlebar, grips, pedals, and seat post are comfortable to the rider. Seat post come in a variety of sizes has for has the length of the tube, and the diameter of the seat tube. Seat tube vary in material from steel, thermal plastics, titanium, carbon, aluminum, and a few other higher end materials. Most seat posts will be round. A seat post will come in diameters from 22.2mm all the way up to 34.9mm. They will be marked on the lower part of the post with its size. These marking are usually stamped into the post, but some will be marked with anodization. These sizes are meant to reference to the bike cycle frame and are only interchangeable with the exact same size seat post. There are a few exceptions for a round pos. Most are an oval shape, or a bent shape for specialized bikes like time trial, road, and some fix gear racing bikes. These usual seat posts are usually quite expensive, sometimes in the hundreds of dollars. Round seat posts will only fit the same diameter of the seat tube on the frame. This means that a seat post with a common 27.2 mm diameter should only be used on a frame with the corresponding 27.2mm diameter seat tube. While it essential to identify the diameter of the both the seat tube and the seat post, it is much harder to determine the correct size of the seat tube on the frame. To do this me can use a micrometer or better yet, actual seat tube sizing plugs designed for bicycle frames. With the sizing tool, it is a matter of inserting the plug till it stops and reading the number on the tool. The tool is stepped in .2mm diameters and usually comes in a set of 2 or 3 tools. Using a micrometer will get a very close but there are a few factors that may yield an incorrect answer. If the seat tube has been deformed and is not round will be an issue. If an incorrect sized post was inserted and the seat collar was tightened down will cause this. When is doubt most manufacturers will have that information. I call to the warranty center of the company will usually get an answer to its size. The seat post itself will have a variety of information on it. Usually, they will always have at least the diameter of the seat post. Along with this will be "the minimum insertion line".	

		The diameter will be printed or stamped on the post. Common seat post sizes include: 22.2, 26.2,26.4,27.0,27.2,30.0,31.6,34.9, etc. You can see that the diameter of the seat post is very tight. This is why we need to find the correct size. You can put a 27.0 seat post into a 27.2 seat tube. It will require the seat collar to be over tightened to clamp the seat post causing the tube to deform and possibly break down the road. A 26.4 seat tube might fit in a 26.2 frame. It will take a lot of force. That amount of force should be a clue that it is not the correct size. The opposite is true if the post slides easily into the tube. It should fit nicely without binding or side to side movement. Another standard mark on almost all seat post is called the minimum insertions line. It will often be just a line a few inches above the bottom of the post. The line can wrap all the way around the post but often is just an inch or so long. Many times, it will be labeled has the minimum insertion line but not always. This line is intended to be the 'minimum" the post should be put into the bicycle frame. This line is established for a variety of reason. Safety of the rider require that a certain portion of the seat post be held in by the frame. This will stop the post from bending or accidentally coming out of the frame. This line also puts enough of the seat post into to frame has not to put extra stress on the seat post/seat tube junction that could cause failure of the seat post, seat tube, or both. Seat post will usually be made of aluminum. Aluminum has a quality of sharing its electrons with the materials around it. This is called galling, or cold welding. Just like the name sounds the post will "weld" itself to the tube around it. If precautions aren't taken, we can have this or corrasion cause the post to be stuck permanently at the height it is installed at. Luckily it is very easy to take precautions against this. Before we install any material seat post into any material frame, we need to wipe clean the seat post. Next is to wipe any old grease out of the seat tube on the frame. Replace the grease with clean fresh grease. Take the brush out of tube grease a smear liberally inside the frame. Plane grease will work for most post. Exceptions are titanium seat post that require ALWAYS ti prep anti seize. This is usually a copper-based grease that prevents the titanium from galling. Carbon fiber is also a seat post requiring a different and specialized gears. This is usually a carbon fiber base with very small balls of carbon that gets squished when it is clamped down,	

		Fortunately, most seat post are aluminum requiring only standard bicycle grease. Ther are a few types of seat post in use today. Most will be rigid in nature. They are essentially a straight tube with a head clamp for the saddle There are also what are called suspension seat posts. Has the name implied, there is a mechanism is the tube to absorb bumps. This can be a steel spring, a spring made of elastomers, and spring of air, or any combination of each. Some have adjustability for different rider weights and styles. Some are more effective, lighter, or more comfortable. They provide excellent comfort and will usually allow the rider to enjoy the ride more Another type of modern seat posts is called 'dropper' posts. They allow the rider to lower the seat post at the post of a lever. Lowering the seat post gets the saddle out of the way of the rider. The rider then can maneuver the bike with greater ability. These posts are almost exclusively used on mountain bikes. When descending, a rider will drop the post as to not interfere with the handing of the bike. Dropper can use air, a spring, or hydraulics accomplish this. Any combination of can ube used and usually is. If air is used has the spring medium, it will usually need some king of hydraulic mechanics has to not slam the saddle into the rider when extended. These posts are always the most complicated and complexed. Most will require them to be sent back to the manufacturer for any repair work. The saddle attaches to the post by the head clamp. There are many different clamp types. Most will fall into a fixed head clamp on the post, or a removeable. The removable type are usually very inexpensive to manufacture and will require a 13mm open box wrench to adjust. They are stamped out of steel and are visibly very different from an integrated head clamp. The integrated head clamp is found on more expensive posts. This style head clamp will save weight and allows for increased micro adjustment of the saddle position verses the stamped steel heads. This style clamp often uses a smaller 5mm or 6mm alien bolt to adjust and tighten the saddle down. This style is vastly superior for its adjustability. Occasionally a cable know has a seat leash will be attached to the frame of the bicycle and the rails of the saddle. This is a safety measure meant to detour thieves from walking off with the seat and saddle. Considering the seat post and saddle can range from $80-$300 it's a good investment for any bike left locked up in the city. **Saddles and Seats:** **https://youtu.be/C-UHRPotFeI** **https://youtu.be/Gwnx5NjxbTM**	

		https://youtu.be/p3RQyrgBWZc **Primary Concepts:** Styles, ergo, padding, gel, racing, cruise, clamps, leveling, adjustments, gel pad, foam, rails, replacement, There are many different styles of seats or 'saddles. They range from the most comfortable you've ever seen like a lazy boy, to the stiffest one you've ever seen. The stiff ones will often be made of specialized materials like carbon fiber, plastic, or thermal plastics. The mountain bike style with have a thin layer of foam, or gel covered in a synthetic leather. The lazy boy style saddles will be huge lots of foam. Some will also have springs on the bottom. Some foam saddle will have gel inside as well. The use of different materials is meant to produce a more comfortable ride for the cyclist. For now, we will just break the saddles into a few categories; the cruiser saddle, the mountain bike saddle, and the racing bike saddle. Each of these will attach to the seat post by using the two metal bars, know has seat rails. Many expensive bikes use their own means to attach the seat/seat post that differ, but most of the industry will use the seat rails. Again, seats will have rails made of steel, but many have more exotic materials like carbon or titanium. These tend to be very expensive and only found on high end bikes. Most city style bikes are equipped with the cruiser saddle. These saddles have lots of padding, tend to be very wide, and lots of adjustments forward, backward, up and down. They are heavier in comparison. They tend to be the most comfortable for a variety of riders. Especially those that don't ride a lot or occasionally gets on a bicycle. The extra width provides extra support for any rider and tends to work very well for larger people. The mountain bike saddle tends not to have as much padding thus keeping the weight down. It is usually not as wide nor as long. There are examples that use gel, but these will never have springs attached to it. A mountain bike saddle style is easily identified by the slimer profile verse the cruiser bike saddle. These saddles tend to be slightly more specialized. They often come in different widths in the rear separated by 10 or 20mm. This type of saddle is cut narrow in the front to allow your legs to go up and down with little restriction. Just like its cruiser counterpart, the are many hundreds of mountain bike saddles to choose from. Many riders prefer it to a cruiser saddle especially for longer distances or more specific rider style. Racing or a road bike style saddle is it just like it sounds like. It is a lightweight highly specialized saddle. They will be the lightest weight saddle you can find. Many people who ride these saddles especially people who are not accustomed to cycling find them to be the most uncomfortable. The people who use these saddles understand this. They prefer the lightweight the aerodynamics that are accompanied with this style saddle. These highly specialized racing style saddles	

		can often cost 2 to $400.00. Therefore, I only recommend the customer select their racing saddle. With these different contours and widths and materials you will find there are hundreds of different types of bike saddles. Which is best for the bike you are working on is always a personal choice of the rider, a generic choice of the manufacturer, or one of both. The personal choice of a rider will often be determined through use. Whether it's a comfortable cruiser bike saddle that weighs 6 or 7 lbs. or a high-end racing saddle which may weigh 300 grams. Knowing the difference between these saddles will help put the right saddle on the right bike for the right person but it will also allow you to make the adjustments needed. Whether it's for the racer the casual rider or the renter. Most rental fleet bikes will come with a cruiser style saddle. Because these are much wider much thicker and tend to have much more padding more people enjoy these for the occasional use. When we set these saddles up it is often better to have the nose of the saddle slightly higher by a degree or two than the rear. This will often accommodate the different riding position of the casual bicycle. This riding position tends to be more upright with a vertical back therefore more of your weight tends to be in the rear and on your sit bones and tailbone. A more aggressive riding style which is found on a mountain bike, or a road bike racer will tend to have the saddle level if not a degree or two down. This is again to help facilitate the fit of the bicycle which will tend to have a back angle of 45 degrees, with a head down position and arms forward. If we had the nose of the saddle up on this style fit of a bicycle it would cause enormous pain for male or female in the frontal groin are. A mountain bike or road bike position is attempting to get more aerodynamic on the bike. The more aggressive position pushes down on the front part of the pelvis. With the understanding that a variety of people will be on a bicycle; a rental fleet it is always best to set the saddle level. This will ensure that the most variety of people will fit the bicycle comfortably.	
	Assessment	**Class discussion.**	
Week 2, Day 2 2.5 Hours	**Introduction:**	**Introductions to Seat post clamps, Quick Releases, stems, handlebar, and grips. Learn the difference between clamps.**	
	Activities	**Seat Post Clamps and Quick Releases:** Adjusting: **https://youtu.be/d-Fz_qrIaCY** **https://youtu.be/rJ1iey8cksE** **https://youtu.be/AUPRsMENdqg** The seat post clamp is the device which clamps the seat post into the seat tube of the bicycle frame. It is essential that these are tightened correctly. Over tightening of this part will cause a deformation of the seat tube and the seat post and may cause the seat post to slip down.	

		If this part is under tightened it will cause the seat post again to slip down affecting the rider's position and could cause injury to the rider. Therefore, we must understand the correct use of the seat clamp the correct torque values and how to make sure it is tight. You will find the on the rare occasion some frames have a very specialized seat clamp built into it, most bikes will have one of two style seat clamps. The first clamp is just like it says it is a clamp. It will use a bolt to squeeze the clamp around the seat tube therefore capturing the seat post inside. Depending on the frame material you will have a 4mm, 5mm or a 6mm bolt to clamp down. These will require different torque values and are usually specified by the manufacturer. If they are not specified by the manufacture, use the corresponding torque value for bolt head chart and start with that torque value. The second type of seat post clamp is referred to as a 'quick release' clamp or a QR clamp. QR standing for 'quick release'. These often only require the use of your hand to tighten them down to the required torque to keep your seat post in place and not twisting or slipping down. They work from a Cam style lever that's usually a few inches long to allow you to gain some perch on the lever. To adjust this, you will tighten the opposite nut up while you flip the lever down to the closed position. You feel you have reached the correct tension which will be obvious because you can see a pattern of the lever in your hand that you use to push the lever down tighten the lever all the way down. Grab the nose of the saddle and twist it back and forth to see if it will slip. Most of the time if you cannot get it to slip this way you have the correct tension on the quick release seat post clamp. If the saddle continues to slip open the quick release lever up give the opposite not 1/2 of a turn and repeat the process until you are satisfied the seat post will not slip. **Stems:** Threadless https://youtu.be/TPYGv6fMnBw Quill Stems https://youtu.be/yM90mfrjkUA Installation https://youtu.be/q4Gedq6kyas Headset Tutorial https://youtu.be/lSd5irFexps **Section Objectives:** Learn about how stems work Purpose of stem	

		Materials Rise, length and diameters Proper installation Bolt torque There are a variety of stems on the market. they include different rises different lengths different diameters and different materials. Each style bicycle whether cruiser, mountain, road, cross, BMX, will all use a different style stem. Most stems on today's market are what we refer to as an A headset style stem. Another style stem that has common is referred to as a quill stem. Both stems refer to how it attaches to the fork of the bicycle. The modern headset style will make up 90% of the new bike market. The quill style is much more affordable, has been around for over a hundred years, and is often used on more affordable bicycles. There is an occasional variant that take elements of both stems, but they are extremely rare or use an adaptor. Usually, the adapter will be quill to headset style stem. The majority of new modern are called A headset style. This refers to how it attached to the fork. These stems will be made of aluminum, some carbon, and a few in titanium. Almost every quill stem is made of steel. Some steel quill stems will use an aluminum base to hold the handlebar, but these are not very common. The stem has a few very important jobs. First it securely holds the handlebar in place. Second it attaches the stem to the fork for steering. And third it puts the rider into a position in space. A headset style stems will slip around the smooth outside of the fork. There will be not threads on the fork. These stems will have 1-3 pinch bolts on its side to secure it to the forks. These stems will have 2-4 pinch bolts to hold the handlebar in place. Bolts will be 2-5mm and every manufacturer will have specific torque values. These values must be adhered to. If not, damage can occur to the stem, or handlebar. It can cause the loss of control to the rider. Repeat. It can cause loss of control to the rider. Please refer to the manufacturer torque specifications for all stems. If it is not clearly marked, either call the manufacturer or refer to the bolt head chart torque specs for a starting point. Overtightening of the stem bolt can and will cause premature failure of stem. This can cause loss of control of the bike, damage to the	

		bike, or damage to components. A few manufacturers will specify a specific tightening sequence. A few manufacturers will have the lower face plate touch the stem, then tighten the upper face plate. The quill stem typically will not incorporate a face plate, instead it needs to have the head of the slightly spread open and then feed the handlebar in front the side of the stem. Care must be taken when applying lever. Only apply enough pressure that will allow the handlebar to slip in smoothly. Some quill stems allow the pinch bolt to thread in from behind. It is possible to use to gently open the face up threading the bolt in from behind and have it press on a penny to spread the face. Once tighten down, every stem needs to be checked for twisting under load. Start by putting the front wheel in between our knees and twist the handlebar side to side vigorously. If it slips tighten with ¼ turn until it does not slip. Twist the handlebars clockwise and counterclockwise looking for any movement. Tighten accordingly. Pay attention to any torque values that came not only with the handlebar but with the stem. Different handlebar materials like carbon or titanium will use a different value than a standard aluminum or steel handlebar. **Handlebars:** Types **https://youtu.be/M1HmMjjBanI** Installation **https://youtu.be/iE1Si-ndgE4** **https://youtu.be/q4Gedq6kyas** Handlebars serve a variety of purposes. One very important is positioning of the rider. Just like a stem, the rider's position can be subtle to drastically changed with the handlebar. Most handlebars you see will be considered either a cruiser, mountain bikes, or road style. Each are easily identified by the corresponding shape. A cruiser bar is the style you will see on many town and beach cruiser bikes. Many commuters will also use them. They provide a very up right and comfortable position for the rider. A cruiser bar will have a rise of 4-6 inches. They will tend to bend up and back towards the rider. This comfortable positioning is typically used for a more universal fit as well.	

		Cruiser handlebars are usually found in only two diameters for the stem. While most will be 1" stem clamp diameter, they can be found in 1 1/8" stem clamp diameter on modern bikes. A mountain bike bar provides a more aggressive riding position. Most will have some rise, but unlike the 4" plus on a cruiser bar, the mountain bike bar will be measured in mm. Most will be 15-60 mm in rise. Like a cruiser bar, they will bend back towards the rider, but its usually only a few degrees. They bar comes in a variety of widths. Most are designed to be cut down to the rider's needs. These bars will be made from numerous materials. Standard chromoly, and steel bars are the normal. The more expensive bar is made of carbon fiber, and titanium. The standard sizing is 1 1/8" stem clamp but can be found in a variety of sizes including 22.2mm, 31.8mm. and 34.9mm. All stems must be torqued down. The higher end handlebars made of carbon fiber need special attention not to overtighten. It is very difficult to do, but if care isn't paid damage can be done. Changing the length of the stem, or the rise of the stem can help the customer feel more comfortable on the bike. Usually if a stem rises more, it will bring the hands up of the rider. This tends to take weight off the wrists and straightens up the back. Most non avid riders tend to enjoy this positioning. While bringing the rider down with less of a rise on the stem puts more weight on the wrists and the front end. This allows more aggressive riding putting the rider in an efficient position. IT places weight on the front end for more traction. This style position usually has the saddle higher for a more efficient pedal stroke has well. Road bike handlebars are easily identified by the 'rams' horn' drop in the bar. These bar curve down and backwards. The overall length of the handlebar providers numerous hand positions. The change in hand positions help for climbing, descending, and riding flats. On flats and descends the rider changes to a more aerodynamic position to cut through the wind. On climbs there the option to put the hand on the top, or the flats. This will open the lungs up providing more oxygen for the climb. Road bike handlebars come in a variety of sizes. Usually measured by the width from 40cm-52cm, and how much the drop is. Just like a mountain bike handlebar, they come in chromoly, aluminum, and carbon fiber. These are the most specialized bar. They will differ in shapes from flats on top, to oval, to traditional round bars. Care must be taken whenever installing these bars. Bolts must be tight enough	

		to hold the rider's weight over the front wheel. Proper installation will end with the weight of the rider pushing down on the front of bars referred to has the hoods to ensure the handlebar does not slip. These stem clamp size will vary again from 1' to 34.9mm in diameter. The wider bars are typically more expensive and more specialized. Putting the rider in a correct position is perhaps the most important role of the handlebar. IT will also allow the mounting of most controls and accessories. The controls will consist of the front and rear brake levers, grips, gear shifters, a throttle for e bikes, accessories like lights and bells, computers, and dashboards. The positioning of these accessories is also crucial. They must be reasonably comfortable and accessible for the consumer. **Grips:** **https://youtu.be/W8VJW_J3QHM** **https://youtu.be/EHJ-cwfTNn4** **Primary Concepts:** Styles, types, removal, installation, lock on, tape. The grip is the connection of the hand to the handlebar. Because everyone has different needs, there are hundreds of styles, variety, and materials for grips. Some are very light made of just foam. These tend not to be durable, but very affordable. The vast majority of grips will be made of rubber or latex. They will have different patterns in the material to hold the palm and finger. Some will have wings on the end to help hold the palm. Some will require tools to install while others simply slide on. There are many tapes that can be wrapped around too. Different thickness is offered as well. Most bikes will come with a basic grip from the manufacturer. Using compressed air is a great way to install, remove, or adjust a basic grip. Simply use an air wand, insert under the lip of the grip, and use the air pressure to slide on or off the grips. Lock on grips only require a 3mm allen key to attach. These grips feature clamps on the end to secure the grip. Care must be taken not to overtighten these grips has well especially on carbon handlebars. Only tighten enough so they do not spin on the bar. Most road bikes use handlebar tape. There is a special way to install these. Starting at the bottom of the rams horn curve, taping from inside by the wheel, the tape is wrapped up the curve in a half overlay pattern being pulled tight with every turn. IT take a while to	

		develop the skill to do this quickly but is impressive when done correctly.	
	Assessment	Discussion of seat post clamps, Quick releases, handlebars, and grips.	

Module #9 Throttles, brake levers, shifters			
Objective: Learn difference in types, styles, and function of each.			
Instructional Materials: YouTube video, online articles,			
Lesson Plan			**Dates**
Week 2, Day 1 2.5 Hours	**Introduction**	**Ebike Throttle, Brake, and Shifters**	
	Activities	**Throttle:** **https://youtu.be/QehDPrRzYIw** Testing **https://youtu.be/MuaY6SzpDHc** An E bike will have the Throttle on the handlebar as well. The throttle will be either a twist style, or a thumb push style. IT will consist of the throttle body and electrical wires to connect to the cpu. The more the grip is twisted the less resistance is seen on the circuit. Less resistance means more power to the hub motor, and more speed for the bike. Most bikes will have a top speed the throttle will allow the bike to achieve. The top speed will be used to give each e bike a classification. Most bikes are limited to 25mph top speed. The throttle connection is another spot that may fail or become disconnected. In a no power situation it is another location to check for connections or broken wires. **Shifters:** Types **https://youtu.be/lSmN6yyLj9s** **https://youtu.be/lSmN6yyLj9s**	

		https://bike.bikegremlin.com/1339/bicycle-rear-shifter-compatibility/ Bicycle shifter compatibility depends on several factors, including the type of shifter (friction or indexed), the number of gears, and the brand of components. Here's a quick overview: 1. Friction vs. Indexed Shifters: Friction shifters are universal and can work with any derailleur, as they rely on manual adjustment. Indexed shifters, however, are more precise and require compatibility with the derailleur and cassette. 2. Number of Gears: The number of sprockets on your cassette or freewheel determines the number of clicks in an indexed shifter. For example, an 11-speed shifter is designed to work with an 11-speed cassette. 3. Brand Compatibility: Major brands like Shimano, SRAM, and Campagnolo have different cable pull ratios and designs, so their components are generally not interchangeable. For example, a Shimano shifter may not work with a SRAM derailleur. If the bicycle has any gearing the shifting equipment will also be mounted on the handlebar. Some bike will have up to 3 chain rings in the front on the crank, and up to 14 rear gears. Many gears use a derailleur system to move the chain up and down the gears, while others have internal gears that cannot be seen, but will use a gear shifter cable as well. The front shifter is always on the left side of the handlebar. The rear shifter is on the right side of the handlebar. The shifter will be either a twist grip, or a thumb push style. Many new bikes rely on only a rear shifter and delete front gears all together. This is due to the increase in the number and range of rear gears. Gears allow the bike to climb and accelerate more efficiently. Gears give the user and the bike more flexibly. **Brakes:** Hydro vs. Cable https://youtu.be/zLGymQYN3r4 https://youtu.be/o-YvMRJunwo https://youtu.be/q4ay12CSF48 https://youtu.be/hg6s596PPRY Types https://youtu.be/348Anu3qC48	

		Coaster https://youtu.be/L2f0e28Dito https://www.bicycle-guider.com/cycling-advice/bike-brake-types/#:~:text=%EE%80%80Bike%20brakes%EE%80%81%20provide There are many ways to slow a bicycle down. Most bikes will incorporate front and rear wheel mounted brakes. Some bikes will just have a rear brake for simplicity. There is theme BMX bikes that have no brakes whatsoever. Most brakes work off applying pressure to the rim itself and are referred to as Rim Brakes. There are also Disk brakes that use a mechanical caliper to squeeze a rotor attached to the hub. These brakes will be either a mechanical cable to acutate the brake, or on more expensive sets hydraulic fluid will be used. While the cable brakes are very simple to adjust and maintain, the hydraulic fluid brake need special tools and special care with the fluids. Hydraulic style disc brake is the most powerful, and most expensive, of all brakes available today. Coaster brakes, only found on rear wheels, use brake shoes inside of the rear hub. When activated by pedaling backwards, these brake shoes expand to put pressure on the inside of the hub shell. Beach cruisers, and more affordable bikes will have coaster brakes. Most of these bikes will be a single speed, without gearing, as well. A Drum brake will have a drum that gets squeezed on the outside of its drum. These works very well and do not require mounts on the fork. They will use a arm to hold the drum in place and that arm will have a tab on the fork to keep it from rotating. Drum brakes can be found on the front, rear or both wheels. Every brake style has advantages and disadvantages. Factors like cost, efficiency, set up, ease of use, quality, and availability will determine what manufacture will spec on a bicycle. Most bike will feature V style rim brakes. These are affordable and very powerful when set up properly. The set up is simple. Adjustments are quick and easy as need.	

Many versions of Rim brakes are on the market, but most can fall into two categories. The first and oldest style is called caliper. These brakes provide the least amount of braking power. They are cable actuated and require extra attention to set up for the most power. Cantilever brakes where the standard of the industry until the mid 90s.

The advancement of brakes led to what is considered the modern standard for cable actuated brakes. They are generically called “V” brakes. They use long vertical arms to squeeze the rim. They are mechanically superior to cantilever brake. V brakes are inexpensive to manufacture and are considered an industry standard.

Front Brake

The front brake is used to slow the bicycle down with power and predictability. There are only a few styles of front brakes, but each are vastly different than the other. Modern bikes will use a V brake, A Drum, or a disc brake. Each has its advantages like ease of use, ease of maintenance, costs, ergonomics, and of course efficiency.

The front brake will be either a braided wire connection or use hydraulic fluid to actuate the brake The front cable brake will use a 2mm braided wire cable inside of a housing to actuate the brake. These cable brakes are very easy to maintain once properly adjusted. The cables will usually go a few years, or decades, before needing replacement. The housing tends to dry out and crack in a few years as well. Both the cable and housing can bend, or be damaged in a crash making in hard, or even unable to use the front brake. The housing will be kinked, or the cable broken in these cases.

These cable systems build up friction between the cable and housing. The braided steel wire can corrode causing even more friction. The cable can eventually become inoperable with enough corrosion. There for every steel braided cable needs to be properly greased when installed. Tune ups should always include new grease of a lubricant.

A hydraulically actuated brake will use a master cylinder to push a fluid medium to the caliper. The caliper will then squeeze a disc rotor causing friction needed to slow the

		wheel down. Hydraulic brakes will use automotive DOT brake fluid, mineral oil, or a proprietary fluid medium. These re considered the most powerful, and the most complicated to maintain. Once properly set up, the fluids will need to be changed, or bleed once a year. The pads will also need replacing. Care must be taken with the fluid has it can spray into eyes. The fluid will also contaminate the brake pads and rotors has well. Each manufacture has its own method and tools to bleed so extra tools and knowledge is also required. When in doubt consult the manufacturer. **Rear Brake** Like the front brake there are a variety of ways to slow the rear wheel down. Coaster brake, rim brakes, disc brakes, and drum brakes are all popular means of braking. There are V brakes, cantilever brake, drum brakes, and disc brakes. They will use a cable or hydraulic fluid. A coaster brake uses the chain itself to actuate the brake when the rider back pedals. Installation, adjustment, maintenance, and replacement will be very similar to the front brake. Bleeding of hydraulic brakes are identical to the front brakes, has is adjustment of cable brakes. Replacement of brake pads is also identical to the front brake. Working on rear brakes tends to be more difficult due to the limited space, extra components like gears, cables, derailleur, and sensors on some E-bikes.	
	Assessment	Discuss the purpose of each component, this may be a written assessment.	
Week 2, Day 2 2.5 Hours	**Introduction:**	**Gears and single speed gearing E-bikes, accessories, forks**	
	Activities	**Gears and Single Speed Gearing:** Basics of Gears **https://youtu.be/Ml9Ojbl2uaw** **https://youtu.be/piryjIPl3NY** Direct drive vs. Geared **https://youtu.be/LUqDtQRHTz8** Gears vs. SS **https://youtu.be/x-8v3XBtkRY** Geared Vs. SS Electric Bikes **https://bikeget.com/single-speed-vs-geared-electric-bikes-how-they-differ/**	

Gears vs Single Speed Bicycles:
The choice between geared bicycles and single-speed bicycles depends on your cycling style, terrain, and personal preferences. Here's a breakdown to help you decide:

Single-Speed Bicycles

- **Simplicity**: Fewer components mean less maintenance and a cleaner look.
- **Lightweight**: No derailleurs or extra gear mechanisms reduce weight.
- **Efficiency**: Great for flat terrains and predictable riding conditions.
- **Cost**: Often cheaper due to simpler construction.
- **Limitations**: Not ideal for hilly areas or varying terrain, as you're locked into one gear.

Geared Bicycles

- **Versatility**: Multiple gears make climbing hills and tackling different terrains much easier.
- **Efficiency**: You can shift gears to optimize your pedaling effort and speed.
- **Comfort**: Ideal for long rides, as gears allow you to adjust based on fatigue and terrain.
- **Weight & Complexity**: Heavier than single-speed bikes, with more components to maintain and repair.
- **Cost**: Generally, more expensive upfront.

A geared electric bike will use a stain gauge attached to the crank. The more stain on the pedals, the more energy or harder the bike will work. When the strain is less, the motor works less. This way the motor and the cyclist work together for the output of the motor.

Bikes that rely on a throttle mechanism to accelerate and achieve top speed without gears, internal or external are referred to as Singel Speeds. Many electric bikes will be in a Singel Speed configuration. There are less parts and usually are easier to use than a geared bicycle. There are no shifters, no extra gearing either external or internal, and no derailleurs. The more throttle that is applied, the more energy the motor puts out. These systems work independent of the crank and do not require pedaling.

Accessories:
Any accessory mounted to the handlebar needs to be tight and out of the way. Accessories can interfere with the brake levers. They can also create a situation where the throttle can stick. When mounted

		care must be taken not to interfere with the operation of many hand controls on the bar. Accessories must be tight enough not to move on their own, but loose enough to move in the case of a fall or crash. This will protect the accessories and the handlebar from damage. **Bicycle Forks:** Fork bicycle forks explained Bicycle forks are an essential part of a bike's structure, connecting the front wheel to the frame and steering system. Here's a quick breakdown to help you understand them better: 1. Structure: A bicycle fork typically consists of two blades (the arms that hold the wheel) connected to a steerer tube, which runs inside the bike's head tube and attaches to the handlebars. 2. Material: Forks are made from various materials like steel (durable and flexible), aluminum (lightweight and stiff), carbon fiber (light, strong, and vibration-damping), or titanium (light and resilient, but expensive). Each material has unique benefits depending on the type of riding you do. 3. Types of Forks: o Rigid Forks: These have no suspension, providing direct control and are common in road bikes, gravel bikes, and some city bikes. o Suspension Forks: Found on mountain bikes, they have shock-absorbing mechanisms like springs or air chambers to handle rough terrain. o Inverted Forks: Feature the suspension stanchions on the bottom for better protection; often seen in some high-performance mountain bikes. 4. Steerer Tube: o Threaded: Found on older bikes, with a quill stem inside the steerer tube. o Threadless: Common on modern bikes, where the stem clamps onto the outside of the steerer tube for better adjustability and strength. 5. Axle Types: o Quick Release: Uses a skewer to easily remove the wheel. o Thru-Axle: Provides more stiffness and strength for better handling, especially on mountain and gravel bikes. 6. Geometry: Fork design, such as rake (offset) and trail, affects handling characteristics. A smaller rake provides more stability, while a larger rake offers quicker steering.	

		The fork the front of the bike that holds the front wheel in place. There are basically two types of forks. One type is called a rigid fork. These consist of metal blades that secure the front wheel in. These forks do not move up and down. They are considered rigid. The other fork type is called a suspension fork. These move up and down to absorb bumps and inconsistencies in the surface. Suspension forks offer a higher level of comfort to the rider. Suspension forks are also safer when properly set up. They tend to be very expensive and are found on every bike from cruiser to mountain bike. The front fork is a critical part of the bike. It has numerous functions besides holding the front wheel. It is also a steering mechanism that has bearings inside the head tube of the frame. The adjustment on these bearings is critical. If these bearings are too tight the rider can lose control do to not being able to steer smoothly. If the bearings are installed loose, it will cause a noticeable clunk in the front end. This will gradually deteriorate into an indexed bearing, a failed bearing, a failed bearing cup, or any combination. These bearings can be either an open caged design in which the bearings are visible and surrounded by a steel cage, or a sealed variety where the bearings are incased inside the bearing shell. Both are serviceable, but replacement of the sealed bearing is preferred when needed. The forks also give the stem a perch. This too is a critical interface. The stem bolts must be secured according to manufacturer specifications. If it is left loose, it will spin around the forks steering tube causing the rider to lose control. If the stem is overtightened, then the possibility of the stem failing is greatly increased. The fork will usually have some mechanism for attaching the front brake. Usually these are actual mounts that accept bolts, but an also just be a support tab depending on the style of the front brake. It is possible to twist the fork legs in an accident. This doesn't happen often, but when the fork blades are bent, the front wheel will not sit evenly in-between the blades. This is visually noticeable. In an accident the front wheel can twist as well. It is standard practice to remove the front wheel and check the alignment of the fork blade. Sometimes just removing and replacing the wheel will fix the problem. More sever conditions will need to realign the blades. In most cases of a bent fork it will need to be replaced. In that case care must be taken to put an exact replacement whenever possible	
	Assessment	Discuss the differences between pros and cons of types of gears.	

Module #10: Bicycle Rim			
Objective: Provide an overview of different rim sizes, rim widths, spoke counts, materials, and uses			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 1, Day 1 2.5 Hours	**Introduction**	Rims	
		Collaborative Learning: **https://youtu.be/MFOng1UXn-g** Defining different rims: **https://youtu.be/lx4dWKSMkN0** Nipples, tension the spokes, different sizes, hole counts, materials, bead hook, tubeless, rim strips The rim is the metal hoop that holds the tire on. The rim, spokes, spoke nipples, and hub make up the wheel. Most rims will be made of aluminum. There are steel rims, and exotic rims made of carbo fiber. The rim allows the tire to be mounted. The rim has a built-in hook that will grab the bead of tire securely when inflated. The hook is a small bead around the inside of the rim. It catches the tire bead has the tire inflates. Most all rims will have small piercings that allow the spoke nipple to rest in. The number of theses holes is called the spoke count. Counts can have as low as 12, and up to 144 spokes of custom beach cruisers. Most rims will be 32 holes, or 36 holes. 36 holes is preferred for the extra strength offered by more spokes. The rim holds the combined tension of all the spokes. These tensions can vary between wheel, but all the spokes will have basically the same amount of tension holding it round and true side to side. Rims will come in a single wall or double wall configuration. A cross section of the rim will show either two walls in a box shape, or a single wall U shaped rim. The double wall is much stronger and is used throughout the industry. Single wall rims are found more affordable bike, are not has strong, and will tend to need more truing.	

		There are tubeless rims that do not require the use of a tube. These specialty rims will have a rims strip, or rim plugs to cover and seal the spoke holes. These tire and rim combinations will need to be used in conjunction with a liquid sealant to fully seal the system and make it airtight.	
	Assessment	In class lab.	
Week 1, Day 2 2.5 Hours	**Introduction**	Spokes	
	Activity	**Spokes** Beginning Trueing **https://youtu.be/MFOng1UXn-g** Next level Trueing **https://youtu.be/xz6nM6SY-aY** The spokes connect the hub of the wheel to the rims. While these are often overlooked, they play a critical role in supporting the weight of the rider and the bicycle over varied terrain. The spoke is amazing considering the amount of compression cycles they go through mile after mile. Stress is put on, then taken off each spoke has it rotates. Spokes are made of steel and are available in a variety of lengths of thickness. The rim, hub, spoke count, and the number of crossing all effect the length of the spoke. The thickness, or gauge is determined by the end use of the wheel. The number of times a spoke touches, or cross another will determine how compliant, or stiff the wheel is. A spoke that goes straight to the rim, without touching another spoke is called a straight or radial spoke. These are the shortest, and stiffest spokes. They will have the most amount of tension placed on the spoke and should only be used on rims and hubs designed for increased tension. A one cross, two cross, or 3 cross spoke lacing pattern is more common. A 3 cross is considered a standard. The 3 cross patterns offer strength with lower tension. This lower tension is more compliant and resilient. Mountain, road, beach, and E-bikes all have different needs requiring different rims, hubs, tires, spokes, and number of crosses. Mountain bikes put a huge amount of stress on the spokes. The varied terrain with constant beating on the rim can push spokes to break. Road bike rims have the most amount of tension placed on the spoke. The increased tension must be paid close attention to when trueing the wheel. A beach cruiser rim will have thicker and a larger number of spokes. Cruiser wheels tend not to get has punished has other variety of wheels. Spoke thickness is measured by its gauge. Usually, the gauge will be 10g up to 18g. The smaller gauge number means the spoke is	

		thicker in diameter. A 14g spoke is considered the industry standard. Is appx 2mm in thickness. An 18 g spoke is very thin and used primarily on higher end wheels. Electric bikes will use a thicker spoke and or a higher spoke count. This is primarily due to the heavier weight of the bike and its electronical components. Many electric bikes will spec hub motor. The hub motor puts a huge strain on the spokes. Because of this most electric bike start with the thicker 12g spoke and a spoke count of 36holes. Motors housed inside the hub shell use very large hub flanges. These style flange requires the use of a much shorter spokes. Shorter spokes are stiffer than a longer spoke. This stiff, shorter spoke builds a stronger wheel. Spokes attach to the hub with its J head. The other end is threaded like a bolt and mates to the spoke nipple. The spoke nipple attaches the spoke to the rim and is used to tension the spoke. Nipples can be made of steel, or aluminum. The gauge of the spoke nipple, and the gauge of the spoke need to correspond to one another. A 14g spoke requires a 14g nipple.	
	Assessment	In class discussion.	

Module #11: The Bicycle Hub			
Objective: Provide an overview of the bicycle hub. Including geared, single speed, front, rear, coaster.			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 1, Day 1 2.5 Hours	**Introduction**	Collaborative Learning, watch videos.	
	Literacy, Contextualized Industry Skills, Workplace Readiness	**Hubs:** Service **https://youtu.be/opommURFB4o** Coaster **https://youtu.be/L2f0e28Dito** Hubs are the center of the wheel. They consist of a right flange, left flange, hub shell, axle and a bearing system. The hub flange will connect the spokes to the rim. The flange will be drilled with	

		the same number of holes has the rim. Flanges can be high or low. This diameter greatly affects the length of the spoke. A high flange hub will use shorter spoke lengths. Shorter lengths build a stiffer, and usually stronger wheel. Front and rear hubs have different purposes and can be drastically different. A front wheel can be basic with just a shell and hub axle. It can have a brake attached to it. Some have electric generators built in. A some will have the electric hub motor on the front wheel. A rear hub can have all those things, as well as gears attached to it. Gears can be internal, or external with the use of a derailleur. Internal or external will use a cable system and shifter to change gears. Hubs without gears are referred to has a Single Speed Hub. These are the simplest of all hub designs. Single hubs with an internal brake are called coaster brake hubs. single speed hubs will have a disc brake attachment, a drum roller brake, or use a standard rim brake. The rear hub holds most of the rider's weight. It is designed with a wider distance between the flanges to yield a stronger spoke and rim angle. Rear hubs can have a higher spoke count as well. More spokes make a stronger wheel to help hold the rider weight. There are a variety of ways to attach the wheel hub to the bike. This is done with and axle. The axle can be attached to the hub or be removable. There are threaded axles use an axle nut to attach to the frame or fork. Threaded axles systems use an open ball bearing, or a caged ball bearing system. The axle accepts cone nuts. Cone nuts threaded on the axle are adjusted for the preload on the bearing. Thread axles will use a 15mm nut on each end to attach to the frame or fork. The Quick Release or QR axle uses a cam lever to keep the wheel attached to the frame or fork. A QR uses a thin steel rod attached to a lever that is opened and closed by hand for securing tension of the hub. A QR hub can use the open ball bearing hub and cone, or better sealed bearings on the axle. First developed for racing, the QR axle can find on every style of modern bike. The newest bikes have a through axle on the hub. A through axle is a large aluminum tube, 10mm-20mm in diameter that threads into the frame or fork. This style axle is inserted through the hub shell and the sealed bearings inside. This style axle is superior for its strength and ease of use. It provides a solid connection	

		securely attaching the wheels. All through axle hubs will use the better sealed bearing system. This allows a smooth bearing and hub assembly while ensuring the axle is securely attached. The through axle system can be found on the front, rear, or both wheels. With a little knowledge of the independent components, we can now dissect the complete wheel. The basic front wheel included the tire, rim, spoke, and hub. Secondary parts like the brake, brake mounts, axle, and any internal or external electrical can be included. The bearing style, and axle style can easily be determined. The number of spoke, the number of spoke crosses, and the thickness of the spoke can also be determined. Rim style, rim diameter, and rim material is available too. The sidewall of the tire will have rim size, tire size, pressure, and other important information on it. The width of the hub, axle type, axle size, and axle length are easily discernable as well.	
	Assessment	In class activity.	
Week 1, Day 2 2.5 Hours	**Introduction**	**The Bicycle Tire**	
	Activity	**Watch videos** **Tires and Tubes** Tire sizing, sidewall information **https://youtu.be/GZRj92Ys4nE** Fat Tires **https://youtu.be/hVxNUJ696qc** Sizing **https://youtu.be/IAup19NnVos** The tire is the connection to the ground for the rider. Things like tire pressure, tire widths, tread patters, tread compounds, tubeless, tubes, and intended design of the tire all effect this connection. The side wall of the tire is a wealth of information. The sidewall will have correct tire pressures marked on it. Date of manufacture, sizes, width, and compound can usually be found there. The tires Effective Rim Diameter (ERD) can be found as well. This number is crucial for proper fit to the bicycles rim. There are industry standards today that mandate tire sizes, but be aware that older bikes, especially older Schwinn models from the 1960-80's have a distinct ERD that modern tires will not fit. The tire must be matched to that Schwinn rim. On the bottom of the sidewall is the bead of the tire. This bead	

		will interconnect with the hook that is on the rim. The bead is usually made of a stiff wire. On more expensive tires, the bead will be made of Kevlar. This not only is a weight reduction but allows the tire to be folded. These are often called folding tires. Most all tubeless tires will incorporate a Kevlar folding bead. Modern tires come in sizes from 8" all the way up to 36". Most all modern adult size bikes will have a tire of 26", 29", or 700c. Cruisers, and most E-bikes will be 26" or 29", while the thin tire on road bikes will incorporate the 700c tire size. These number refer to the diameter of the tire. The widths will be from 1" up to 6". The size will be written on the sidewall of the tire. The first number is the tire diameter, and the second is the width of the tire. It will look like, 26 x 2.3, 29 x 2.6, or 700c x 32 c, with different width to choose from for each tire size. Tubes for different tire sizes will correspond to the tire diameter and width as well. Though not has critical due to the tubes ability to stretch, a tube should be selected has close to the corresponding tire as possible. There are two typers of valves on inner tubes. One is called a Schrader valve. This is the same has what a car tire uses. It is in mass use on more all types of bikes. It uses the same air chuck that a automobile would use. The other is called a Presta valve. It differs significantly from the Schrader valve. The top of the valve on a Presta valve is unscrewed to allow in inflation. Once inflated, it is screwed down sealing the tube. This way not obstruction can keep the valve open leaking air Modern tire pressure can range from 6psi, to well over 100psi. This is depending on the tire and rim combination. Therefore, it is critical to see what the tire manufacturer recommends by reading the printed information on the sidewall of the tire. Most cruiser bikes with wider tires will be 20-35 psi, road bikes will have 80-120psi, and fat tire bikes will have pressures has low has 6 psi. Due to this wide range of tire pressures, it is highly recommended to always check the sidewall of the tire for the manufacturer recommended pressure. Tire size greatly effects the air volume in the tire. The thin tires always require more air pressure to run efficiently. Those higher pressures tend not to has comfortable and are found mostly on road racing style bikes where efficiently is most desirable. The wider tires on commuters, cruisers, and mountain bikes provide more comfort and more tractions verse the higher-pressure thin tires. These tires can incorporate a tube to hold the air pressure, or a tubeless variety. The tubeless variety will use a sealant inside of the tire to fill any small hole in tire, or rim to seal it to hold air. This tubeless system does not rely on a tube and therefore is susceptible to less flats, and less repair. A tubeless	

		system is not highly dependent on-air pressure as well. Therefore, it can be run at a lower pressure for more traction, more comfort, or both. Although these are advantages, the tubeless system requires a more expensive tire, and a sealant. The sealant needs to be replaced or recharged every few months to be effective. This extra expense is usually found on higher end bicycles. There is a great alternative to the tube or tubeless system. This system works incredibly well for commuters or rentals. This system is called a solid core tire. This style tire will not get a flat. Has the name implied, it is a solid rubber tire with no tube, or sealant. These only require replacement when the tread wears out. The drawback is the difficulty in mounting the tire, and the way the road feels to the rider. The solid tires tend not get has much traction and are not has comfortable as well. The offset of no flats, and no tire maintenance make these tires very attractive to the commuter or for a rental fleet. Tires can also be very wide. Referred to has fat tires, these are probably the most comfortable tires on the market. At over 3" in width, sometimes up to 6", the high-volume air tires can be run has low as 8 psi. The lower air pressures make this tire roll over the ground absorbing the shocks, provides a flatter pattern on the ground, and tends to float over obstacles and lose ground like sand.	
	Assessment	General discussion of the different styles of bottom brackets.	

Module #12: The Bicycle Cranks			
Objective: Understand cranks and crank sets.			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 1, Day 1 2.5 Hours	**Introduction**	Cranks and crank sets, lengths, bolt pattern, gear rings, chain wheels, pedals,	
		Crank Arms 1x 2x 3x set ups **https://youtu.be/BjgmFHCutGk** Removal and installation **https://youtu.be/zbza6CA6YSI**	

		The crank connects the rider to the chain rings or single speed chain wheel. The crank will have a dedicated right and left side crank. This had to do with the fact that the left crank has left-handed threads. Left-handed threads use a reverse tapping. Most all bolts and nuts are right-handed threads. The nut or bolt is turned to the right to tighten up, left to loosen. Hence the saying 'Righty Tight'. A bicycle crankset uses a left-handed thread on the left crank to insure pedaling forces will not unscrew the left pedal. To install the left pedal, it needs to be threading in counterclockwise. The right crank arm is a normal right-handed thread. Therefore, care must be taken to put the left pedal in the left crank arm, and the right pedal in the right arm. Most pedals will have a L or R on the pedal spindle to indicate which pedal is left-handed threads, verse the right-handed thread pedal. The crankset will hold the chain rings, in the case of multiple gears, or the chain wheel if it only has a single ring on the crankset. Multiple front chain rings allow a larger spread of the gears. This allows the bike to climb hills and accelerate with greater efficiency. The gear selection is controlled by rider using a gear shifter. The shifter is located on the left side of the handlebar for front chain rings. There can be up to 3 front chain rings, but modern bike design utilizes one or two chain rings in the front. Often a single ring will be 32 tooth, given a good medium gear range. A double ring set will have a small gear, usually around 28 teeth, and a larger gear in the 40's. This allows a bike to climb steep hills with the smaller gears. The larger gear allows for a higher top speed. Using the gears make the bike more efficient and allows the rider to tune the gearing for the terrain. Crank arms come in different lengths. They can be changed to suit the rider or the frame needs. Most cranks will be 165mm, 170mm, and 175mm in length. The longer crank is said to give more torque to the rider and works for a variety of riders. The shorter 165mm crank arm is well suited for lower bikes or smaller rider. Cranks arms attach to the bottom bracket in a variety of ways. Most will be a square tapper and a fixing bolt to hold it in place. Others will slip over the bottom bracket spindle and use a pinch bolt to secure. There are a few other styles of Bottom Brackets as well. Care must be taken when selecting the proper tool to service, tighten, or remove the BB.	
	Assessment	In class exercise**.**	

Week 1, Day 2 2.5 Hours	**Introduction**	Bottom Brackets	**2.5 Hours**
	Activity	**Watch videos** **Bottom Brackets** Basics **https://youtu.be/Wq_CfuYo2fA** Styles **https://youtu.be/e-8G1G9QNX8** Types **https://youtu.be/xUtOeFJJycg** The bottom bracket consists of the bearing shell on the frame that houses the bearings the bottom bracket spindle rotates on. The bottom bracket spindle connects the crank arms to one another and allow the rider to rotate the crank to propel the bike forward. The bearing can be loose, a caged system, or a sealed bearing variety. The loose or caged system is a less refined, more cost-effective system. These systems use a threaded cone nut to provide the preload and adjustments on the bearings. The open design makes this system vulnerable to contamination. While not a modern design, when properly adjusted this system will last a very long time. Sealed cartridge bearings are a superior design to the open bearing. It uses a seal on either side of the bearing to repel contaminants. The cartridge bearing seals keeps the grease inside and clean requiring less maintenance. This overall design supports the rider's weight and pedal forces much better. Sealed bearings create less friction for a more pedal efficiency. Besides holding the bearings for the crankset, the bottom bracket is a great place to put an electronic motor. The frame triangulates in that area making a strong intersection to house the motors. Electric bikes with motors placed in the bottom bracket are refereed to frame motors verse the hub motor bike. Frame housed motor bicycles will use normal hubs front and rear. They will often have gears on the rear. These bikes are the most efficient and tend to be found on more expensive bikes.	
	Assessment	Class Discussion.	

Module #13: Chain rings and Chain wheels
Objective: Understand the purpose and use of chain rings and chain wheels

Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 1, Day 1 2.5 Hours	**Introduction**	**Chain rings and Chain Wheels** Ring Replacement **https://youtu.be/9NBxcIDxUZg** **https://youtu.be/_cjmW_HJv48** Types and compatibility **https://youtu.be/dyzilTpqRM0** Bolt Circle Diameter defined **https://youtu.be/hBBOijv__ts** The chain rings will have different Bolt Circle Patterns that will match the crankset. In the past there were a variety of BCP which make finding the correct chain ring for a particular crank somewhat difficult. Stores had to stock numerous rings without knowing exactly what they might need. Fortunately, Industry Standards forced the manufacturers to come up with a universal BCP. The industry standard is now called a 4-Bolt pattern. This means that any 4-bolt pattern chain ring will fit any 4-bolt pattern crankset. There is a few exceptions to this, but in general it is considered safe to install any 4-bolt pattern crankset with any 4-bolt ring. The chain wheel does not use any bolts to attach to the crankset. The chain wheel attaches around the base of the crankset, or the spindle on the bottom bracket. It will use on large thin nut to mount, and splines on the ring to index the ring. Chian wheels can be found on single speed bikes, as well as geared bikes. On geared bikes it is reared to has a 1 x 10. The second number, in this case 10, refers to the number of gears in the rear. Bikes can be a 1 x7-1 x 14. Care must be taken when selecting the chain, shifter, and derailleur on geared bikes. The chains come in a variety of widths. Bikes with more gears require a thinner chain. A chain designed for a 7-speed bike will not work on a bike with more rear gears. Likewise, the derailleur needs to have enough movement for the gear range. The Shifter needs to match the number of gears as well. Therefore, cassettes, chains, chain wheels, and shifters need to all be of the same number of gears.	
	Assessment	In class discussion.	
Week 1, Day 2 2.5 Hou	**Introduction**	The Chain	
	Activity	**The Chain:**	

		https://youtu.be/vSLnA14hKkI chain types **https://youtu.be/V8JnvlcmyGE** chains in general **https://youtu.be/O0YibMDWBAw** geared chains **https://youtu.be/88tDcVvS7mU** single speed chains **https://youtu.be/VdUQKVMPF5I** replacement **Primary Concepts:** widths, gears, single speed, quick links, chain pin, maintenance, replacement time Chains are amazing. The job of the chain is to take the power of the rider, or motor, and transfer that energy to the wheel for propulsion. This sounds easy, but considering the job, the thin chain is amazing. The chain consists of the inner and outer plates, rollers, and thin steel rods called chain pins to connect all the parts together. These are called the chain links. The chain has inner and outer links in a set. There is a smaller width, and connected to it will the thicker link. The chain is in constant motion, constant tension, and is constantly wearing down. It can hold 80,000 psi. With proper maintenance a bicycle chain can be used for thousands of miles. A completely rusted chain can often be salvaged with lube. A chain can be shortened, or links can be added. A chain can be salvaged with other links for a similar chain. A chain pin is used to connect all but one link making up the chain. A master link, or a Quick link is used to connect the chain together. That link can quickly be removed. It makes installation, maintenance, and replacement very easy with no special tool required. Chains are available in a single speed or one geared version. A single speed chain is very wide and will only work on a single speed set up. Geared chains are designed to be shifted up and down a gear stack. Gears will have 7-14 individual cogs. Due to the number of gears, a chain will have different widths to accommodate cog spacing. A 14-speed cassette will require a thinner chain than a 9-speed cassette. Due to all the moving parts in a chain, it will wear down. Has the chain wears, the distance between the rollers gets wider. This will wear the cassette and the chain ring as well. A worn cassette or a worn chain ring will not let a new chain sit down on the teeth. Because of this, when the chain is loaded with power, it will skip over the teeth. There are gauges to determine how much the chain has worn. A new chain will usually require a new cassette, and a new chain ring in most cases to work properly. However, a slightly worn cassette or chain ring will accept a new chain, but the chain will wear into those parts quickly. The chain is one of the few parts that will work from one manufacturer to another. This is due to industry standards on the length and width of the chain. All 8 speed chains are dimensionally identical one another no matter the manufacture.	

		The same is said of any other number of gear chains. All 9 speed chains are the same width and length.	
	Assessment	In class discussion.	

Module #14: The Chain Replacement			
Objective: Replacing the chain. When to replace. Compatibility of chain and gears.			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 1, Day 1 2.5 Hours	**Introduction**	**Chain Replacement** **https://youtu.be/88tDcVvS7mU** **https://youtu.be/O0YibMDWBAw** Park tool chain sizing **https://youtu.be/VdUQKVMPF5I** Park tool replacement **https://youtu.be/88tDcVvS7mU** Single Speed Chain replacement New chains, used chains, twisted links, stiff links, chain wear, chain compatibility. Chains will need to be replaced. The chain will wear out. With enough miles on the chain, it can break needing replacement. Has the chain wears it also wears the gears and cogs. A chain will wear to a point that it will not sit in the cogs or gears correctly. In this instance when power is put on the pedals the chain will 'skip' over the teeth. The bicycle does not accelerate and the rider can lose control. This can happen not only when the chain wears out, but if a new chain is put on old cogs, chain rings, or gears. It is recommended any time a chain is repaired or replace the bike is test rode. When a chain wears to the cogs and gears it will get to a point where it needs to be replaced. When a chain is to this point then the cogs, rings, and gears will nee to be replaced as well. The new chain will not sit into the worn gears causing a 'skip' when power is applied A chain gauge is a tool that is used to measure the wear of a chain. The gauge measures the distance between the rollers on the chain. The tool should be used on 2-3 different sections of chain to get a medium measurement. Has mentioned before, when is distance of the rollers get to a certain point the chain is considered worn out. The gears, cog, and rings will need to be replaced as well at this point.	

		Most gauges measure between 0.0mm and 1mm of chain roller wear. When a chain gets to .75mm worn it is considered worn out. A chain can be replaced before this occurs. Flats, slow leaks, tube valves, tube styles, tubeless, mystery flats, to patch or not to patch, solid core	
	Assessment	In class activity.	
Week 1, Day 2 2.5 Hours	**Introduction**	Bicycles Cassettes	
	Activity	**Cassette:** **https://youtu.be/iTJ3taJHOn8** Types and tools **https://youtu.be/9KAaP7pbFV0** Installation Cassette is the cluster of gears on the rear wheel of the bike. Usually, a cassette will consist of 8-14 gears on a stack. This stack of gears will thread on the rear hub or slip over the cassette body. The cassette gives the rider the ability to climb steep hills or accelerate quick. The use of the gears can also give the e bike more range between charges. Not all bikes will have a cassette. Many choose to use a single speed bike for the lower cost and ease of maintenance. The rear bike hub needs to be designed for the number of gears. The more gears require the frame to be wider in the rear. Therefore a 7-speed cassette will not work properly, if at all, on a 14-speed rear hub bike. Care must be taken to ensure that the proper cassette is used. The chain will need to match the number gears on the cassette. Recall a chain comes in different widths to match the cassette gearing spacing. The gears on a 10-speed cassette will have different spacing than a 14-speed cassette. The chain, shifter, and derailer must match to work proper. Along with the number of gears, many manufacturers have proprietary components. These only work well with other parts from the same manufacturer. There are few instances where similar parts will work from different manufacturers. Each manufacturer will attach the cassette to the rear hub by different means. These will require special tools to remove and install. Not one mounting style is better than the other. One component that can often be used between different manufacturers is the chain. Care must be taken to match the number of gears to the corresponding chain. A 10-speed cassette needs to be matched to a 10-speed chain. An 8-speed cassette needs to be matched to an 8-speed chain etc. One gear in the rear is referred to as a Single Speed. Most will use what is called a freewheel to mount the cog on the hub. The cog and its freewheeling mechanism is a self-contained unit. Freewheels are very durable and economical. The freewheel will	

		wear and will need to be replaced with the chain at maintenance interval. Like the cassette it uses special tools to install and replace. On more expensive bikes, there the cassette version on a single speed. It uses a thin cog installed on a modified cassette body to hold the single cog. These cogs are easily swapped for different gearing options. The single speed cassette will require special tools, much like a geared cassette to install and remove. Like the cassette, and freewheel, a single speed cassette needs the chain to be replace with the cog at maintenance intervals.	
	Assessment	In class activity.	

Module #15: The Derailleur and Shifter			
Objective: Comprehend the purpose and operations of the derailleur and shifter.			
Instructional Materials: YouTube video, online articles			
Lesson Plan			**Dates**
Week 1, Day 1 2.5 Hours	**Introduction**	**Derailleur and Shifter** Overview **https://youtu.be/B37TW_YVC8E** Adjustments **https://youtu.be/UkZxPIZ1ngY** **https://youtu.be/kkL1vze6M4A** The shifter can be found on the right side of the handlebar for the rear gears, and on the left side of the handlebar if the bike has the front gears. Its job is to pull a cable, or release tension on the cable to maneuver the rear derailleur up and down the cassette. This changes the final drive ration of the bike allowing the rider to climb hills and accelerate. When the rear derailleur climbs the cassette to the larger gears, it gives a gearing advantage to the rider. These gears are used to climb hills. The lower gears yield a higher gearing ratio for acceleration. The shifter needs to match the number of gears. The number of gears needs to match the rear derailer as well. A 10-speed shifter needs to pair to a 10-speed cassette, 10-speed chain, and 10-speed derailleur. Many manufacturers use their own pull of cable on the shifter, and different styles rear derailleur as well. Care must be taken to	

		match all these components with the same companies. There are a few parts that will work in between manufacturers. These are specially designed to accommodate different specifications. That rounds out the basic components of most bicycles. You should have a good basic knowledge of the components on a frame, and what the job is of each component, how to tell the difference between components gears, brake types, and shifters. Chain types matched to the appropriate gearing. The appropriate shifter needs. General knowledge gearing. Gear selection, hub types, and axle types. Difference in cables and housing. Brake types and mounting styles. The importance of torque specifications.	
	Assessment	In class activity.	
Week 1, Day 2 2.5 Hours	**Introduction**	Derailleur and Brake Cable Replacement New cables, used cable, stretch, hysteresis, types, coatings	**2.5 Hours**
	Activity	**Cable replacement:** **https://youtu.be/0zD5wT16Rvw** replacement **https://youtu.be/Mq-WAze1F_Q** park tool replacement **https://youtu.be/Xg5MrDgLhHI** park tool brake cable replace The cable on the bike will control the braking systems and the gear shifting on the bike. These cables are made of braided steel. With proper maintenance a cable can go the life of the bike without replacement. When a cable does fail, it us very easy to replace. There are two types of cables on a bike. They differ in the thickness of the cable, and the lead piece on the end that attaches it to the brake or shifter mechanism. A brake cable is always thicker than the derailleur. It will have a large circular lead head on it. In comparison, a shifter cable will be much thinner than the brake. The shifter cable will have a thin lead head on it that fits nicely in the shifter. Due to the size of the lead head, it is difficult to get a brake cable, and a derailleur cable mixed up. To replace the cable, simply remove the old cable. On brake levers the lead head is easy to see in the lever. Loosen the mounting bolt on the brake mechanism and pull the cable out of the housing. Once out of the housing, remove the lead head from the lever and discard the cable. Insert the new lead head on the new cable into the lever. Now apply a thin coating of grease to the rest of the cable. This helps keep the friction down inside the cable housing. Insert the cable into the cable housing. Pull the cable through housing and through the pinch bolt on the brake mechanism. Pull the cable tight and tighten the pinch bolt. Squeeze the brake lever hard to 'stretch' the cable. If there is any slack in the lever, loose the pinch bolt, repeat pulling the cable tight through the pinch bolt and	

		tighten the pinch bolt down. Small adjustments can be handled with the barrel adjuster on the brake lever perch.	
	Assessment	In class exercise.	

Final Exam: Hands-On Practice and Applications (6 hours)	
Simulated Scenarios (4 hours): Using provided scenarios, students will complete inspection reports, maintenance logs, and complete repairs on a single E-bike.	**Standards/ Aligned Text**
Team Collaboration (2 hours): Practicing the completion maintenance logs for E-bike fleet. Students will access their skills and competencies when checking an E-bike for maintenance, repairing an E-bike, and ordering replacement parts. Evaluation will be based on a rubric.	