PROJECT ONE: MILESTONE 1 – COVER PAGE

Team Number: 31

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Avery Thurston	thurstoa
Gurleen Dhillon	Dhillg25
Kavi Gurunathan	gurunatk
Olutayo Oluwasegun	olutayoo

MILESTONE 1 (STAGE 0) – PRE-PROJECT RESEARCH MEMO

Team Number: 31

You should have already completed this task individually prior to Design Studio 3.

1. Copy-and-paste each team member's pre-project research memo on the following pages (1 team member per page)
   → Be sure to indicate each team member's Name and MacID

We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their Pre-Project Research Memo with the **Milestone One Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone One Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 1*** of the milestone

Team Number: 31

Please list Team Member that is submitting the memo.

Full Name: Gurleen Dhillon	MacID: Dhillg25

Copy-and-paste the pre-project research memo for one team member in the space below

As climate issues relating to sustainability and clean energy are rapidly becoming a huge concern, many refuse to switch over to more renewable sources of energy (e.g. wind, solar, biomass, hydrogen, and geothermal) due to it being very costly (for installation and maintenance), the geographic limitations, and its' reliability compared to fossil fuels [1], but over the last decade wind farms are being installed rapidly across the world [3]. Wind turbines are machines that resemble fans, often have three aerodynamic blades that rotate around the horizontal axis (or occasionally the vertical axis), and have the ability to "harness the energy of the wind in order to turn a turbine" [4]. When wind energy blows twice as fast, it could potentially make eight time more energy [5]. They have been used to provide energy and promote sustainable development to remote locations such as small towns and villages [4].

A wind turbine is composed of usually three aerodynamic blades which are supposed to tun with ease in the wind [4]. They are attached to the central hub of the wind turbine (located on the horizontal axis) and it spins a generator shaft and produces energy [5]. The turbine also has to have two to three small curved blades at the top of the turbine, which mimic airfoil wings on an aircraft, and spin when there is a wind blowing past the turbine blades [5]. The amount of energy that a turbine produces is proportional to the area swept by the blades [5]. The turbine also contains a generator which is powered by the small blades and a gearbox to increase the motion of the blades [5]. The blades and components of the turbine must meet strict mechanical properties in today's world. They must have high rigidity, be resistant to torsion and fatigue, but must also be flexible for easier repairs [2]. Along with this, the wind turbine as a whole must also offer excellent corrosion resistance and high temperature tolerance [2]. Materials which are used to make the wind blade include resins of glass fiber reinforced polyester, glass fiber reinforced epoxy, and carbon fiber reinforced epoxy [2]. The shape and size of a wind turbine is not a necessary requirement, but changes with the purpose of the turbine [5].

Copy the references below (use IEEE format)

[1] Clean Energy Ideas, "Why Don't We Use More Renewable Energy," Clean Energy Ideas [Online]. Available: https://www.clean-energy-ideas.com/energy/renewable-energy/why-dont-we-use-more-renewable-energy/. [Accessed: Sept. 26, 2020]

[2] M. Froese, “How Are Blade Materials And Manufacturing Changing To Keep Up With Larger Turbines?,” Wind Power Engineering[Online]. Available: https://www.windpowerengineering.com/blade-materials-manufacturing-changing-keep-larger-turbines. [Accessed: Sept. 26, 2020]

[3] P. Botsaris & E.I. Konstantinidis, “Wind turbines: current status, obstacles, trends and technologies,” Research Gate [Online]. Available: https://www.researchgate.net/publication/311339042_Wind_turbines_current_status_obstacles_trends_and_technologies. [Accessed: Sept. 26, 2020]

[4] Clean Energy Ideas, “What Are Wind Turbines,” Clean Energy Ideas [Online]. Available: https://www.clean-energy-ideas.com/wind/wind-turbines/what-are-wind-turbines/. [Accessed: Sept. 26, 2020]

[5] W.E. Eubanks, “How Does Wind Energy Work,” Green And Growing [Online]. Available: https://www.greenandgrowing.org/how-does-wind-energy-work. [Accessed: Sept. 26, 2020]

Team Number: 31

Please list Team Member that is submitting the memo.

Full Name: Kavi Gurunathan	MacID: gurunatk

Copy-and-paste the pre-project research memo for one team member in the space below

Over the past few decades, the use of fossil fuels to produce energy has caused the effects of climate change to become more apparent. This has forced governments to find alternate forms of energy that are renewable, and therefore, safer for the planet. One such renewable source of energy is wind power. According to a Global Wind Energy Council report, wind energy makes up about 2% of the global energy supply, and this energy comes from onshore and offshore wind farms [1]. Onshore wind farms are placed on land in large fields. However, the problem of land availability must be considered. Also, "wind turbine noise and their visual impact on the natural environment" are some reasons why people may stray away from the idea of onshore wind farms [1]. These issues do not apply to offshore wind farms, as they are farther away from residential areas. The higher wind speeds near water allows for higher energy production, and the higher demand of energy near coastal regions allows a higher demand for more wind turbines [1]. It is for these reasons that offshore wind farms are one of the fastest growing energy supplies in the world [1].

There are many important factors that come into play when designing a wind turbine, one of them being turbine design [2]. Since only about 80% of the energy in a stream of air can be extracted, each part of the wind turbine must operate correctly to ensure maximum energy production [4]. The blades must be designed with a "small twist and taper along their length from the tip to the root" to maximize air flow and minimize drag [3]. They must also be of the correct length; if they are too short, they will not achieve maximum efficiency, however, if they are too long, they will be too expensive and too heavy [3]. Wind turbine blades can now be made to lengths of up to 40 m [2]. The number of blades is also important. Turbines generally have three blades, which maximizes efficiency, minimizes

cost, and creates a lower noise level [3]. Material must be considered as well; the blades should be light enough to spin freely, but strong enough to sustain high drag forces [4].

In conclusion, wind energy is a good source of renewable energy, and the improvement of technology will create a bigger market for wind turbines.

Copy the references below (use IEEE format)

[1] X. Sun, D. Huang, G. Wu, "The current state of offshore wind energy technology development," *Energy,* vol. 41, no.1, pp. 298-312, March 2012. Available: https://www-sciencedirect-com.libaccess.lib.mcmaster.ca/science/article/pii/S0360544212001685?via%3Dihub.

[2] A. Campbell et al., "Wind Power," Energy Education [Online]. Available: https://energyeducation.ca/encyclopedia/Wind_power#:~:text=The%20three%20main%20factors%20that,than%20having%20occasional%20high%20winds. [Accessed September 24, 2020].

[3] "Wind Turbine Design," Alternative Energy Tutorials [Online]. Available: https://www.alternative-energy-tutorials.com/wind-energy/wind-turbine-design.html. [Accessed September 26, 2020].

[4] R. Thresher, M. Robinson, P. Veers, "Wind Energy Technology: Current Status and R&D Future," [Online]. Available: https://www.nrel.gov/docs/fy08osti/43374.pdf. [Accessed September 23, 2020].

Team Number: 31

Please list Team Member that is submitting the memo.

Full Name: Avery Thurston	MacID: thurstoa

Copy-and-paste the pre-project research memo for one team member in the space below

Wind turbines are a positive, non-invasive way of creating energy to be used on the power grid. Most people only know one type of wind turbine, the horizontal wind turbine. This is a vertical base and the blade is perpendicular to the wind. It is also the most common because of its strength and efficiency [1]. However, there are many types of wind turbines including vertical axis wind turbines which tend to be less efficient because they are setup closer to the ground where there is less wind [1]. Some advantages of wind energy is that it is renewable and sustainable, good for the environment, it has low running costs and It reduces fossil fuel consumption. However, some disadvantages are that wind turbines are expensive, noisy and can scare off land wildlife as well as kill flying wildlife [2]. In general, the state of wind turbine technology is still increasing to find the most efficient and cost productive wind turbines.

When designing a wind turbine there are a few factors and design features that need to be considered when creating a wind turbine. For example, if you are creating a horizontal axis wind turbine you would be able to change the size of the shaft and blade, the curve of the blade. The material used for the wind turbine and the design of how the wind turbines look aesthetically. The most important factor is the strength of the wind turbine so that it can withstand and environmental effects like heavy storms and corrosion. Of course, these changes would have to be made on a situational bases and probably would not be the same every time. This must also balance out with the cost which was about $1 million per megawatt in 2019[3]. With these mechanical properties it allows a good outline for what a wind turbine needs to perform well.

Copy the references below (use IEEE format)

[1] J. Hanania, B. Heffernan, J. Donev, "Types of wind turbines," Energy Education [Online]. Available: https://energyeducation.ca/encyclopedia/Types_of_wind_turbines. [Accessed : September 25, 2020].

[2] Clean Energy Ideas, "Advantages & Disadvantages of Wind Energy," Clean Energy Ideas [Online]. Available: https://www.clean-energy-ideas.com/wind/wind-energy/advantages-and-disadvantages-of-wind-energy/. [Accessed : September 25, 2020].

[3] WPED Staff, "IntelStor expects wind turbine prices to recover 5% in next two years," Windpower Engineering [Online]. Available: https://www.windpowerengineering.com/intelstor-expects-wind-turbine-prices-to-recover-5-in-next-two-years/. [Accessed : September 25, 2020].

Team Number: 31

Please list Team Member that is submitting the memo.

Full Name: Oluwasegun Olutayo	MacID: olutayoo

Copy-and-paste the pre-project research memo for one team member in the space below

Fossil fuels have been the most used source of energy over the years, in the sense that the burning of these fuels has generated most of the energy required to power our homes and businesses [1]. Unfortunately, we are beginning to pay the price. The use of these fossil fuels has caused a lot of damage to the environment, ranging from air to water pollution and also global warming [1]. Not to talk of all the petroleum based products such as gasoline, plastics and diesel fuel being dumped carelessly around the environment. It is time to move toward a clean energy future, thus leading to the introduction of the wind turbine. First of all, what is a wind turbine? A wind turbine, generally referred to as a wind energy converter is a device which enables the conversion of kinetic energy to electrical energy [2]. These wind turbines are mainly manufactured in various sizes. Smaller sizes being used to power appliances requiring meager amounts of power supply and larger sizes used to power areas requiring larger amounts of electricity. These larger turbines have become an important source of renewable energy and are being used by various countries as part of their scheme to reduce their reliance on fossil fuels to the barest minimum [2].

When designing a wind turbine, we take three main factors into consideration. These factors include: wind speed, air density and blade radius (Wind turbines are designed to maximize the radius of the rotor blade to maximize power output from the turbine, thus larger blades allow the turbine to capture more of the kinetic energy of the wind by moving more air through the rotors) [3]. Another important factor to also take note of is the location of the wind turbine as they need to be in areas with a lot of wind on a regular basis [3]. Also, looking at the general outlook of the wind turbine, we notice that it is elevated on tall post or tower which enables it reach wind currents travelling at high speeds, it has some sort of rotational device (known as blades) like that of a fan and they are mostly made from steel [4]. Taking design into consideration, we have two types of wind turbines known as the Horizontal Axis Wind Turbines (HAWTs) and the Vertical Axis Wind Turbines (VAWTs) [4]. The HAWTs which are mainly used in farms have three blades. The blades turn a rotor shaft, which is attached to an electrical generator; this generator is what converts the wind energy into electricity [4]. The electrical generator is mainly located at the top of the tower and is usually accompanied by a gearbox which controls the speed of the generator thus allowing the HAWTs operate at variable speeds, allowing them collect more energy on windy days [4]. Another feature of the HAWTs is that they have a braking system to stop rotation of the blades if the force of the wind becomes too great [4]. On the other hand, the VAWTs consist of a centre rotating shaft which contains a number of aerofoils [4]. Unlike HAWTs, they do not need to be pointed into the wind thus making them ideal for locations with variable wind directions [4]. The VAWTs are also made of steel

but the aerofoils can be made of other materials [4]. Another interesting feature of the VAWTs is their ability to start themselves, meaning that they do not require a separate starting motor (this feature is only limited to the Savonius VAWTs) [4].

Copy the references below (use IEEE format)

[1] Melissa Denchak, "Fossil Fuels: The Dirty Facts," NRDC [Online]. Available: https://www.nrdc.org/stories/fossil-fuels-dirty-facts. [Accessed: September 29, 2020]

[2] "Wind Turbine," Wikipedia [Online]. Available: https://en.wikipedia.org/wiki/Wind_turbine. [Accessed: September 29, 2020]

[3] Allison Campbell, Jordan Hanania, Braden Heffernan, James Jenden, Ellen Lloyd, Jason Donev, "Wind Power," Energy Education [Online]. Available: https://energyeducation.ca/encyclopedia/Wind_power. [Accessed: September 29, 2020]

[4] Kate Miller-Wilson, "Design of a Wind Turbine," Love to Know [Online]. Available: https://greenliving.lovetoknow.com/Design_of_a_Wind_Turbine. [Accessed: September 29, 2020]

*If you are in a team of 5, please copy and paste the above on a new page

MILESTONE 1 (STAGE 1) – INITIAL PROBLEM STATEMENT

Team Number: 31

Stage 1: Initial Problem Statement:

What is your first draft of the problem statement? Keep it brief and to the point. One or two sentences should be enough. **For initial problem statement you should be focusing on main function(s) of wind turbine.**

Create a wind turbine that fully utilizes all its components in order to maximize the production of wind energy and is durable enough to withstand environmental conditions.

MILESTONE 1 (STAGE 3) – REFINED OBJECTIVE TREES

Team Number: 31

For each engineering scenario, you will be submitting a modified/revised objective tree agreed upon by the group. Each branch of objective trees should have a minimum of 3 layers. This can be hand-drawn or done on a computer.

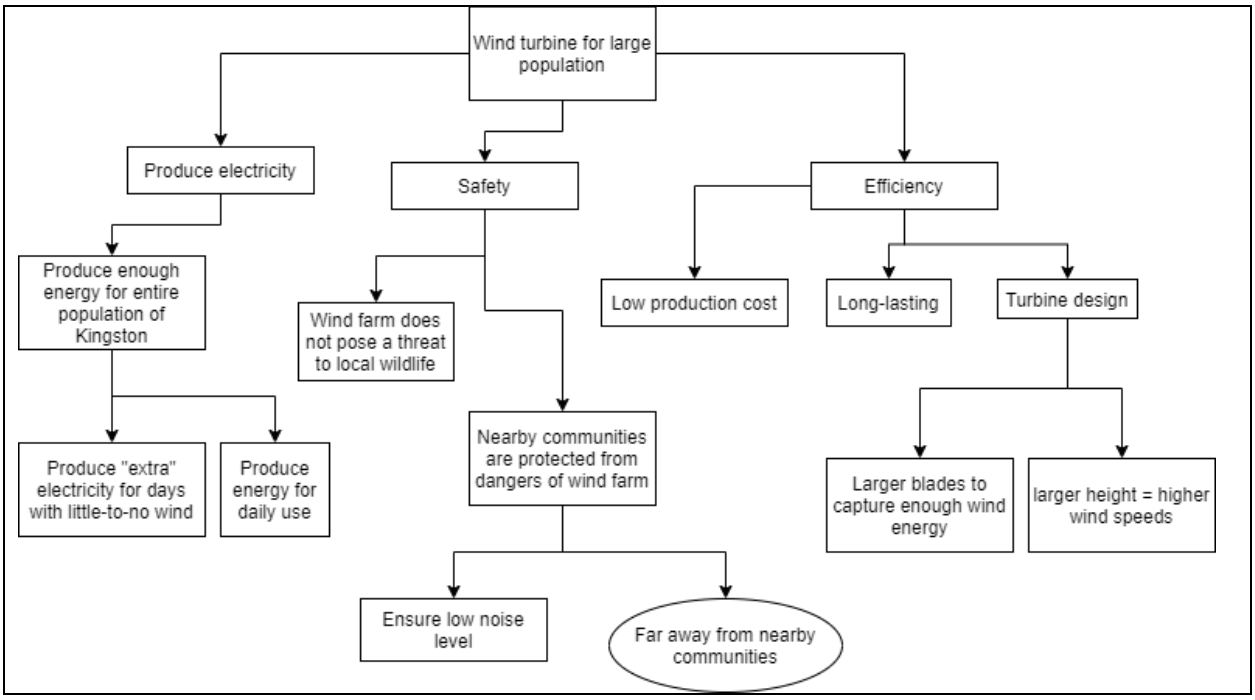
Engineering Scenario #1

The title of the scenario

Renewable Energy for a Large Population

Team objective tree diagram for scenario #1

Please have a copy of refined and finalized team objective tree for scenario #1.



Team Number: 31

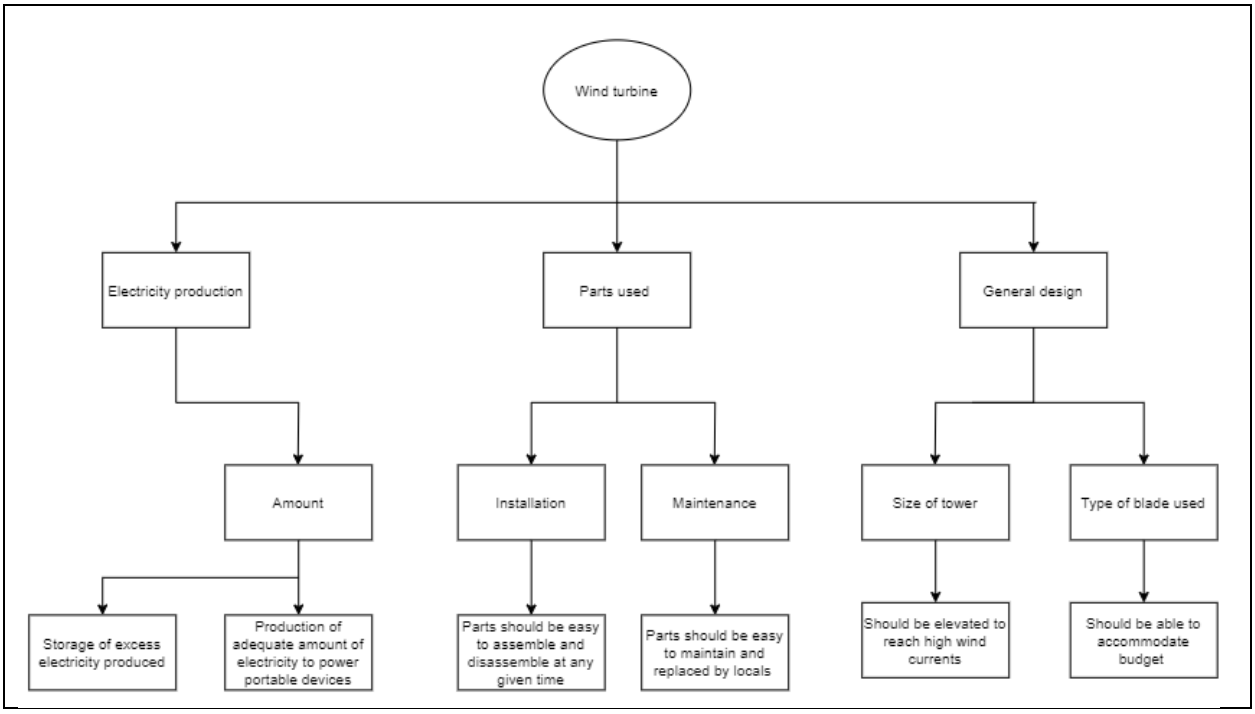
Engineering Scenario #2

The title of the scenario

EWB Humanitarian Aid Mission

Team objective tree diagram for scenario #2

Please have a copy of refined and finalized team objective tree for scenario #2.



Team Number: 31

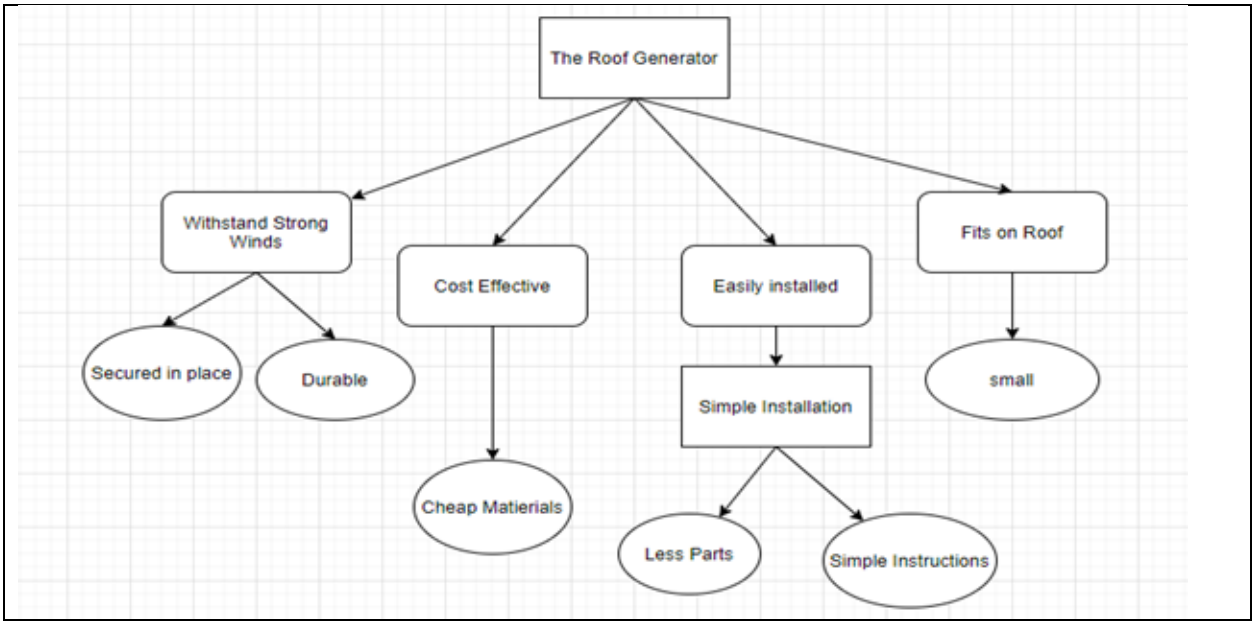
Engineering Scenario #3

The title of the scenario

The Roof Generator

Team objective tree diagram for scenario #3

Please have a copy of refined and finalized team objective tree for scenario #3.



Team Number: 31

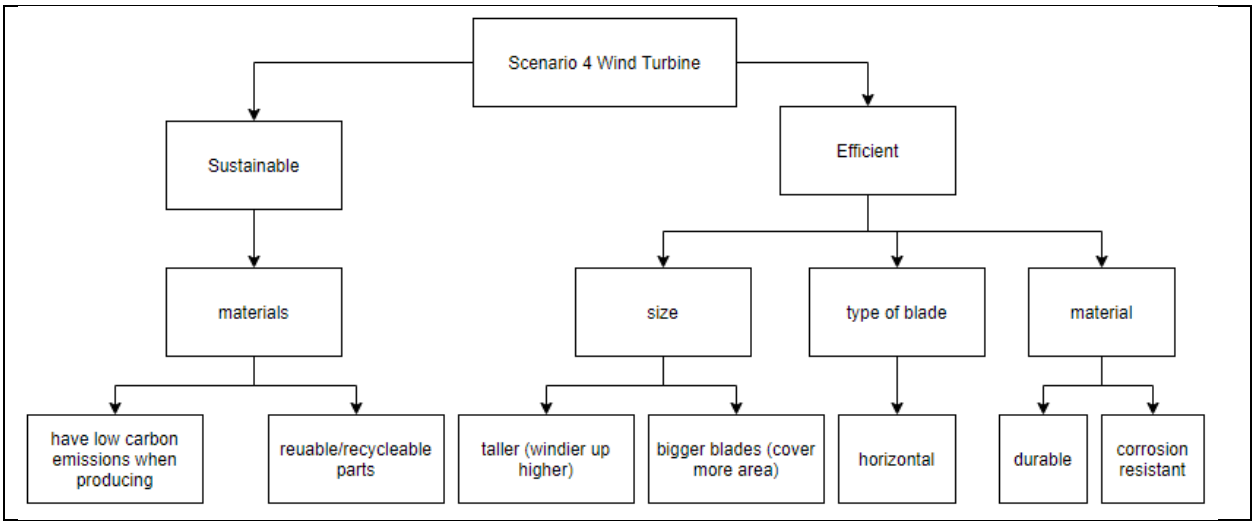
Engineering Scenario #4

The title of the scenario

A Pioneer In Clean Energy

Team objective tree diagram for scenario #4

Please have a copy of refined and finalized team objective tree for scenario #4.



Team Number: 31

Refined Objective Tree