



DRONE PROJECT

**DESIGNED BY :
AHMED ELDIARBY**

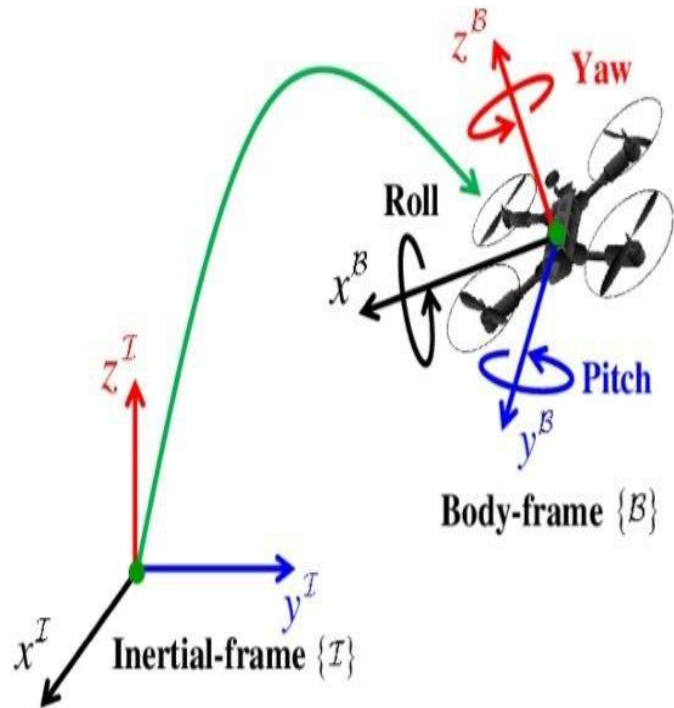
Abstract

A drone is defined as an aerial vehicle which uses aerodynamic forces to provide vehicle lift, can be recoverable or expandable, can be piloted remotely or fly autonomously, does not carry a human operator, and can carry a non-lethal or lethal payload. Beforehand, drones were used only for military applications like spying on both international and domestic threats because they do not put the life of a pilot at risk in combat zones.



In addition, they do not need rest, which enables them to fly as long as there is fuel in the craft. Currently, the developed drones can be used in a vast number of applications, such as deliveries, policing, monitoring flooded areas, and many others that were discussed in this report. The mechanism described in this report targets multiple disciplines that fall under the Mechatronics umbrella, which comprises mechanical, electrical, and digital components. This project focuses on designing and developing a general-purpose drone that can be used in different applications, specifically in deliveries. The developed drone design has been simulated using different software, including MATLAB, SolidWorks, Gazebo, and Proteus. Different analyses were made on the drone to choose the best available material, guarantee its longevity, and ensure its safety. A propeller was analyzed as well to determine the air pressure and velocity impact on it. Besides, the flight dynamics of the system and the reasons why each component was chosen were explained in detail. In addition, mathematical equations to better understand the system's flight dynamics and electrical calculations to determine the flight autonomy were clearly shown and explained.

Keywords: Drone, delivery, mechatronics, propeller, SolidWorks



The Flight Dynamics

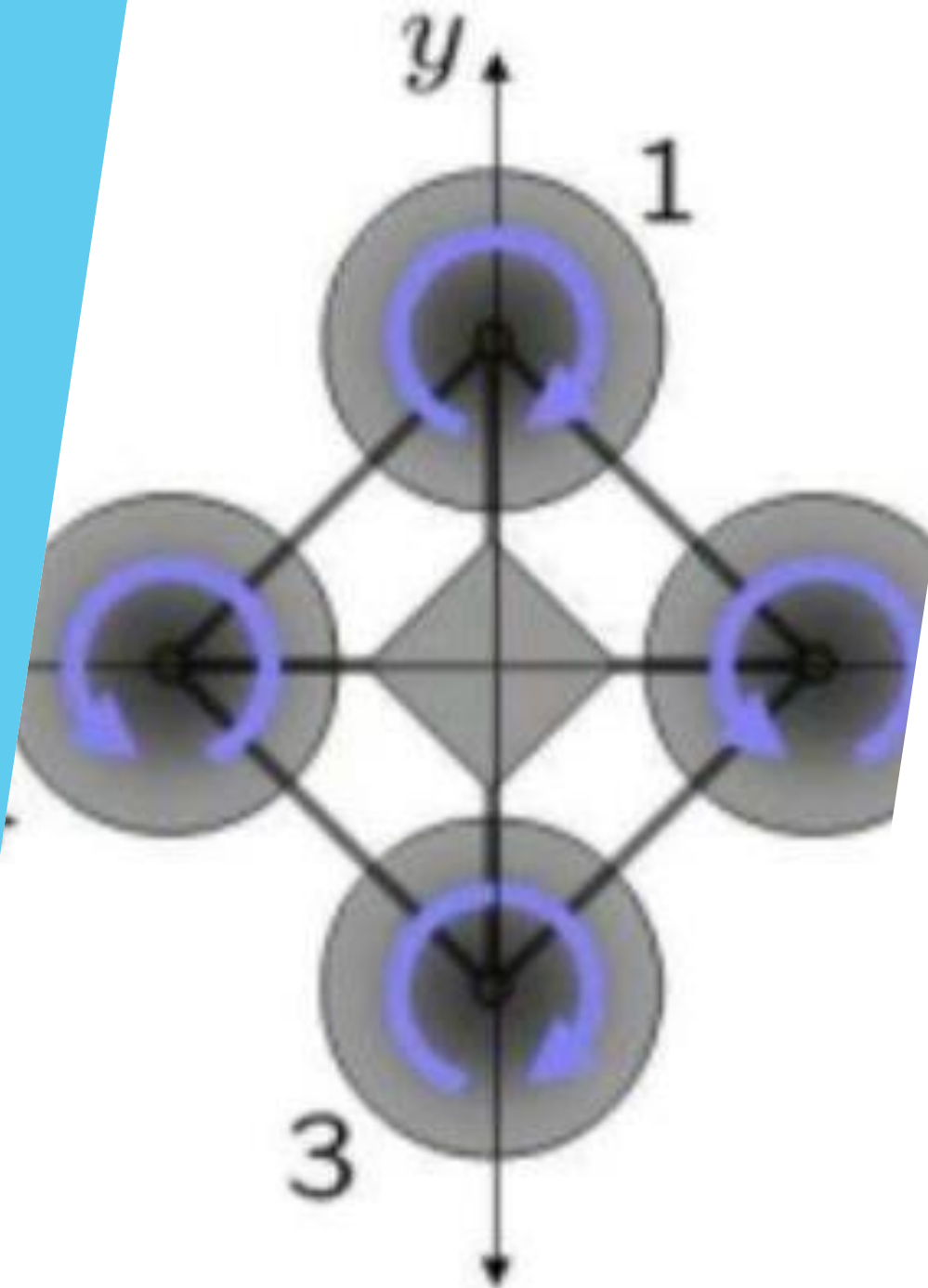
Before talking about the 6-DoF and start deriving the quadcopter's dynamics, two frames

in which we will operate need to be introduced. The first one is called the inertial frame and is

defined by its position that is with respect to the ground along with the gravity pointing in the

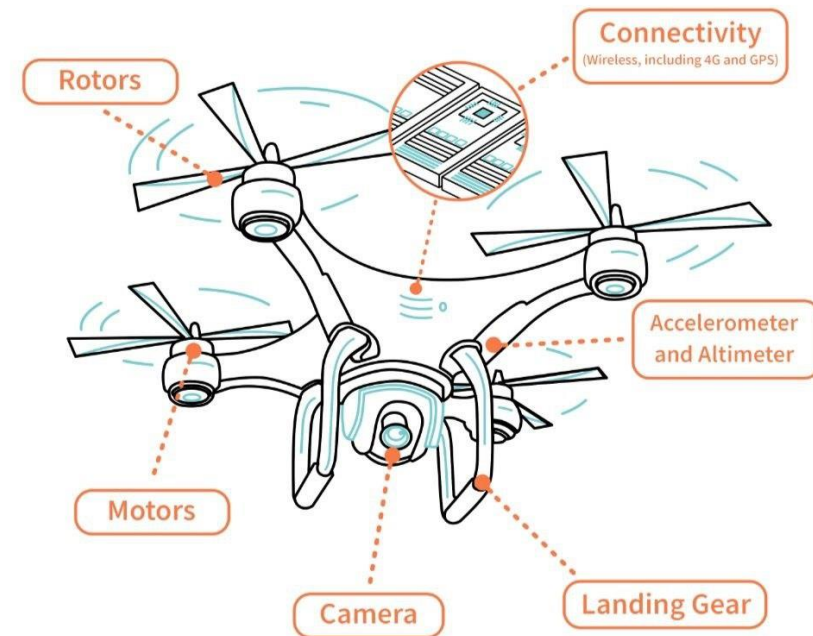
negative z-direction. The latter is called the body frame which is defined by the quadcopter's

different orientation. The figure below illustrates my explanation

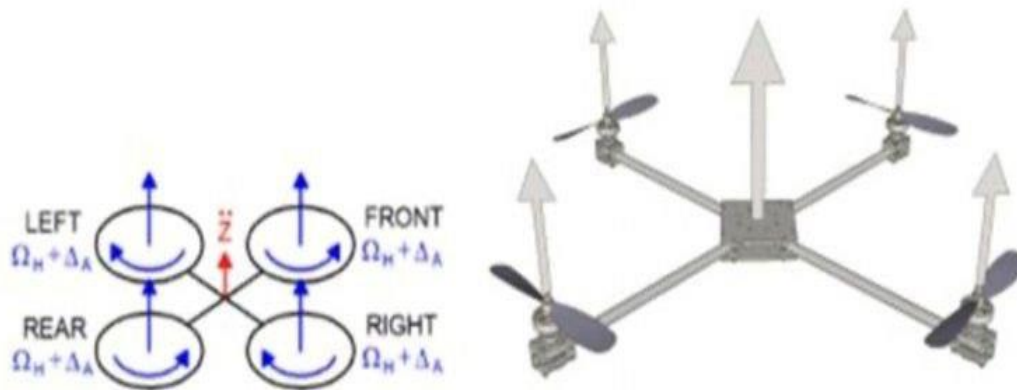


► The quadrotor's position and attitude can be controlled by changing the speed of each motor to a desired value. Some moments and forces are performed on the drone such as: the thrust produced by the rotation of the motors, the rolling and pitching moments produced by the thrust of the difference of the four rotors, the gyroscopic effect which only appears in the drone construction lightweight, the gravity, and the yawing moment which may be cancelled out when 2 rotors rotate in the opposite direction. Hence, the propellers and motors are split into two parts, which in each group has two diametrically opposite motors. Thanks to their rotation's direction, we can distinguish as shown in figure 8 that left and right propellers (number 1 and 3) are rotating clockwise while rear and front ones (number 2 and 4) are rotating counterclockwise

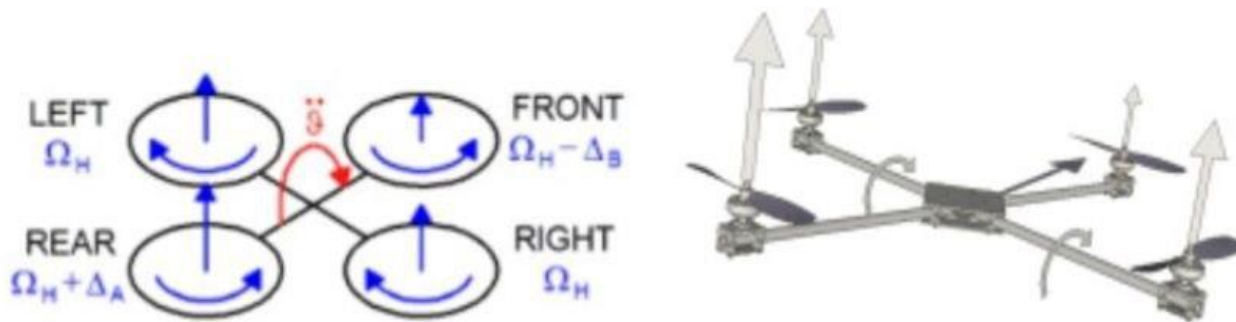
► **Six Degrees of Freedom (6-DOF)** Six degrees of freedom are required to describe any time space motion of a rigid body and can be divided into two groups, which are the barycenter and the movement around it. There are three barycenter movements named as three translation motions that make the quadcopter move longitudinally (forward and backward), vertically (upward and downward), and laterally (right and left). In addition, there are three rotation motions along three axes which make the drone move rotationally among each axis to produce roll, pitch, and yaw movements.

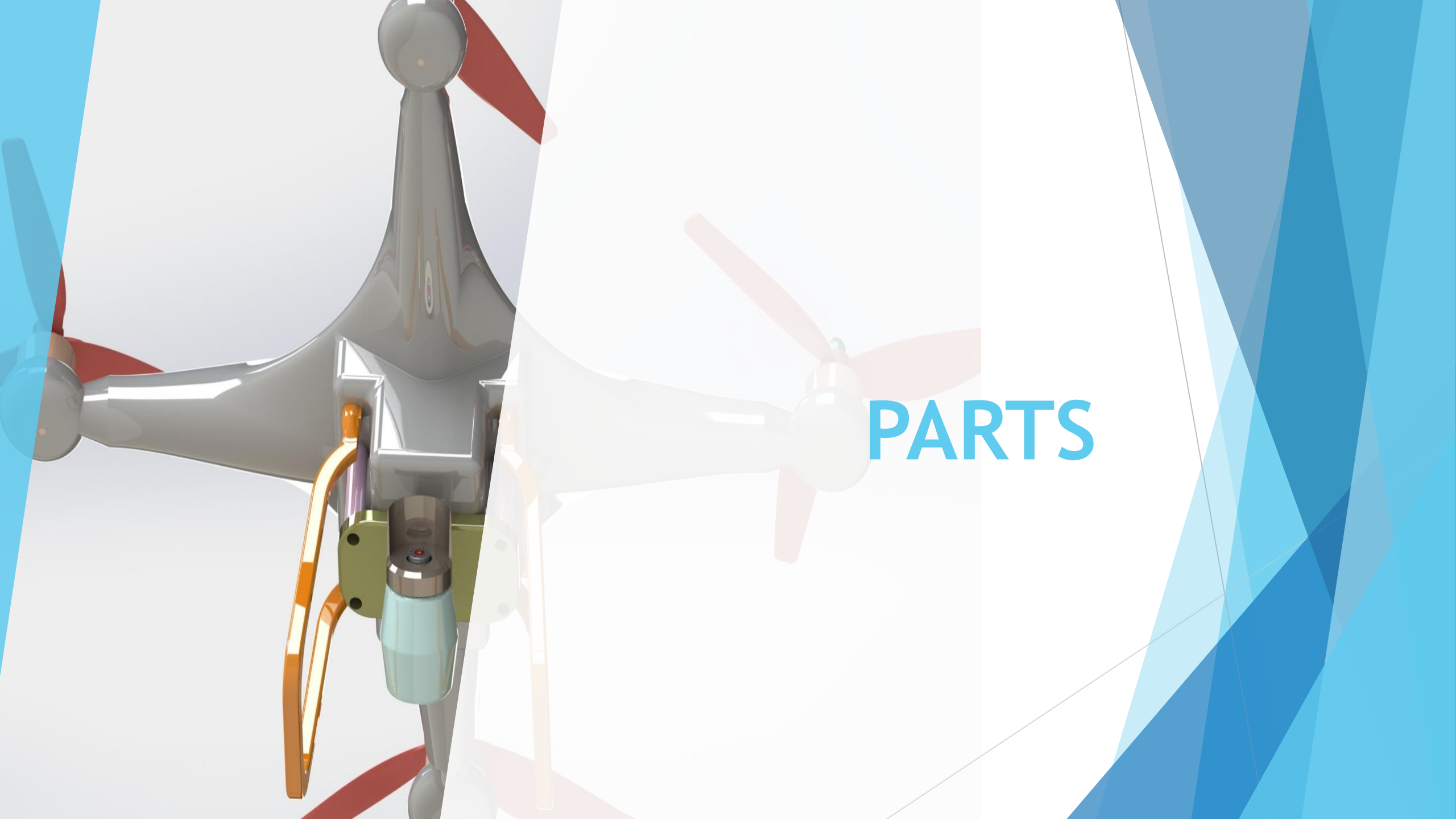


► **The Throttle Movements:** This movement is provided by decreasing or increasing the speed of all the propellers with the same amount, which leads to a vertical force with respect to the body frame that lowers or raises the quadrotor. The vertical direction of the body frame coincides with the one of the inertial frames when the quadcopter is in a horizontal position. Otherwise, the inertial frame's both the horizontal and vertical accelerations are generated by the thrust provided. The throttle movement in the quadcopter sketch is shown in figure 9. The propellers speed Ω_i , $i = 1, \dots, 4$ are equal in this case to $\Omega_H + \Delta A$. For each. The ΔA (rad/s) is a variable (positive one) that represents with respect to the constant value an increment. The ΔA should not be too big because the quadrotor would ultimately be affected by saturations or non-linearities.

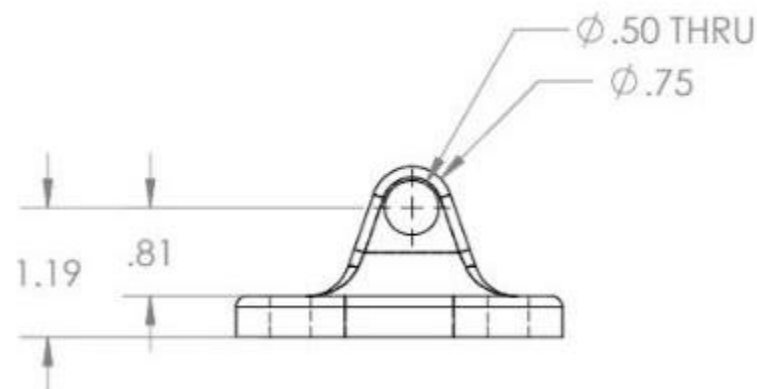
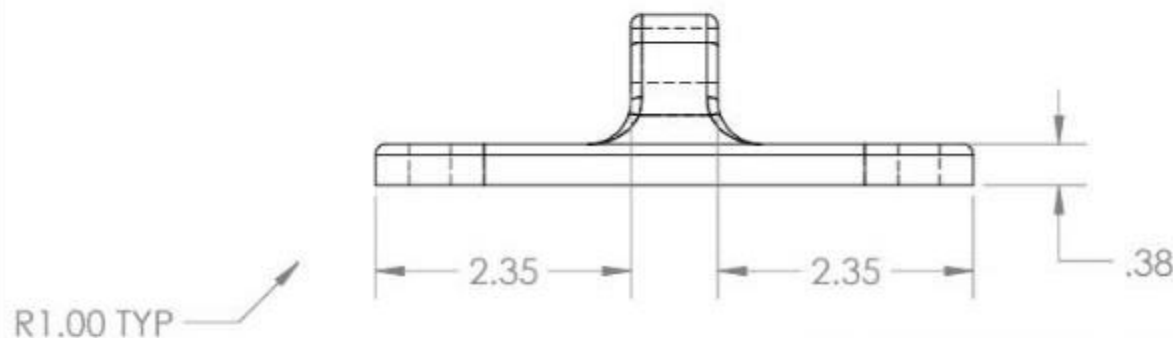
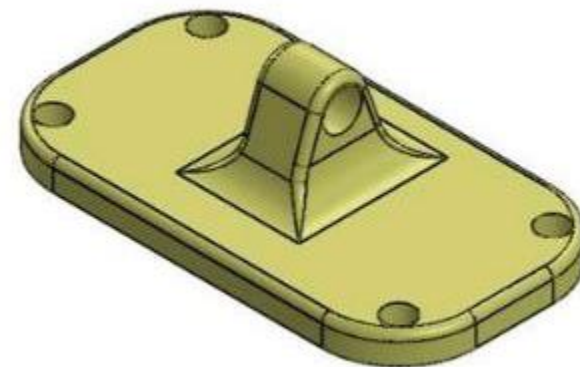
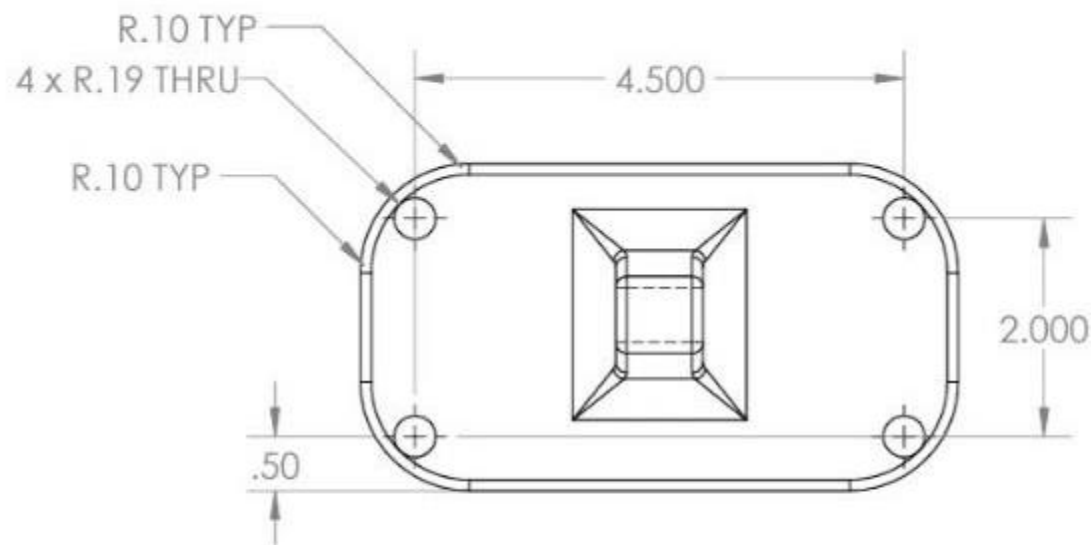


► **The Roll Movements:** This movement is provided by decreasing or increasing the left and right of the propellers' speed. With respect to the x- axis, this leads to a torque (figure 10), which makes the quadcopter tilt side to side (left or right). In hovering is the same as the overall vertical thrust; thus, this movement yields only to a roll angle acceleration. Figure 10 shows the roll movement on a quadrotor sketch. The ΔB positive variable is chosen so that the vertical thrust is remained unchanged. Similar to the previous case, it should not be too big because the quadrotor would ultimately be affected by saturations or non-linearities.





PARTS



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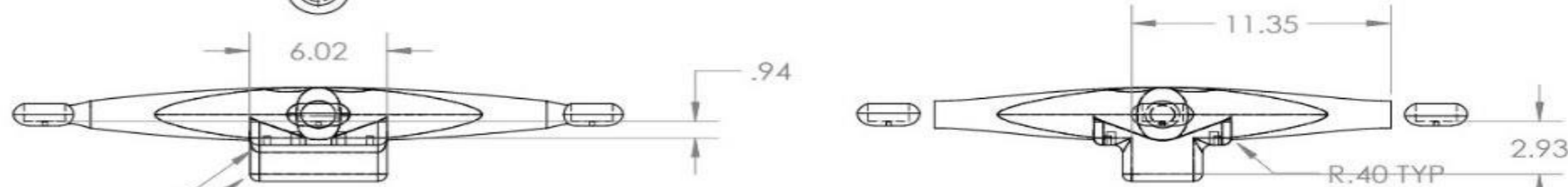
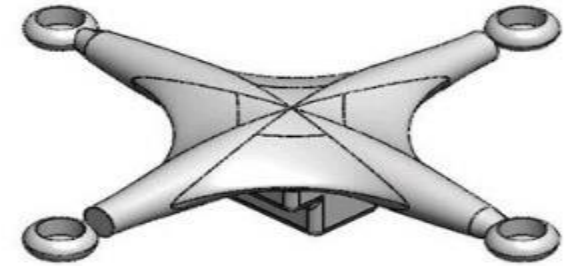
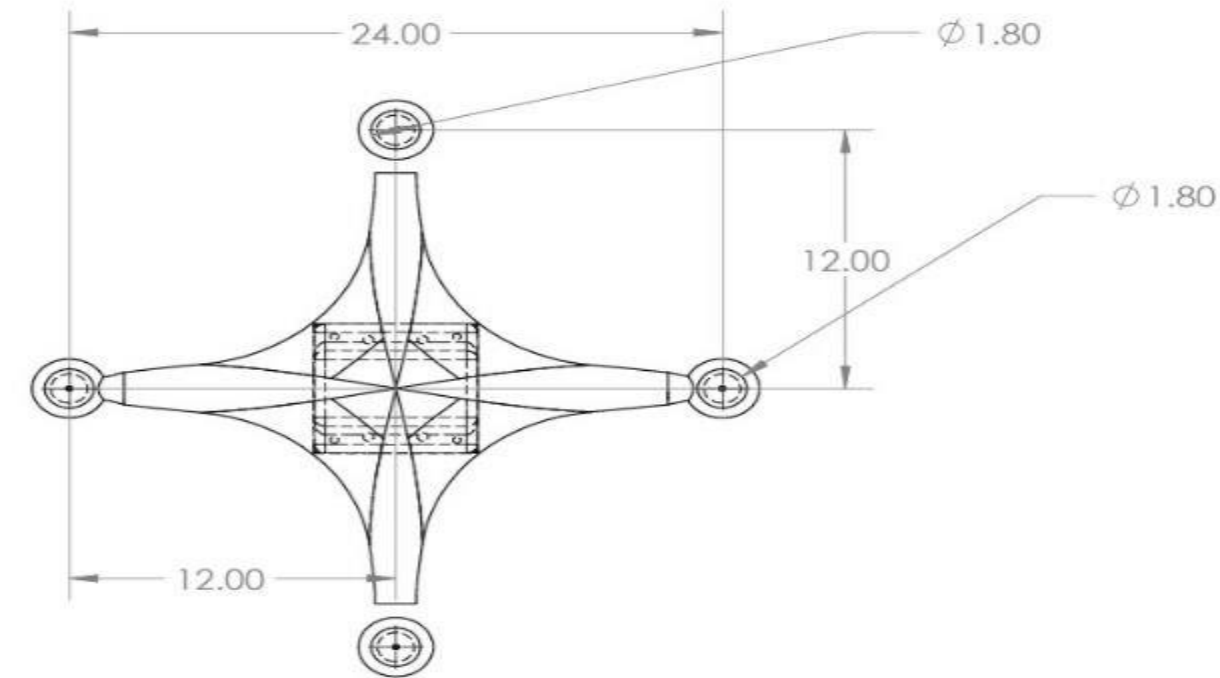
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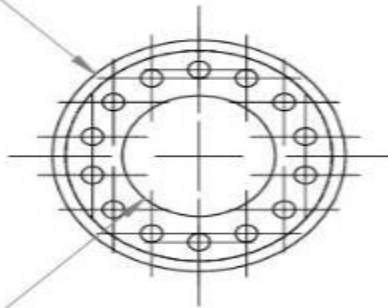
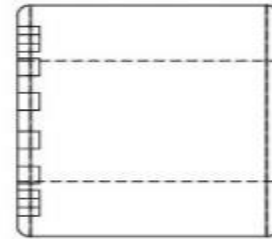
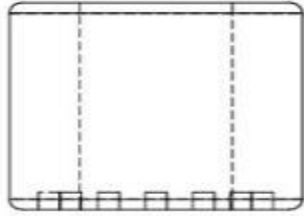
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AHMED ELDIARBY

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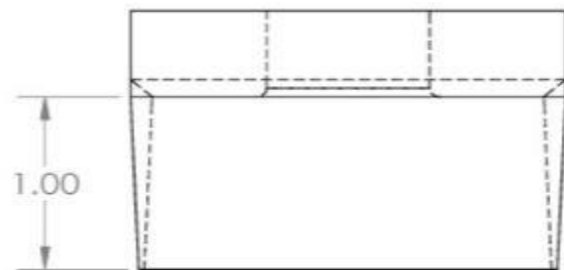
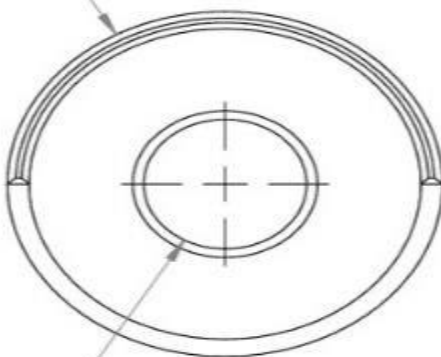
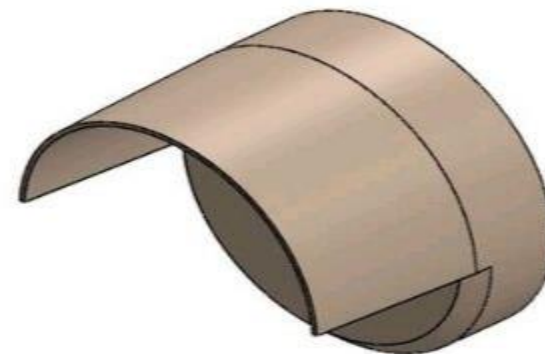
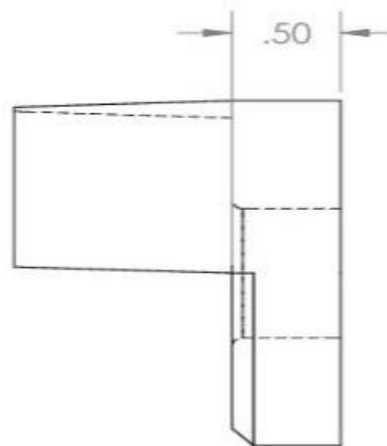
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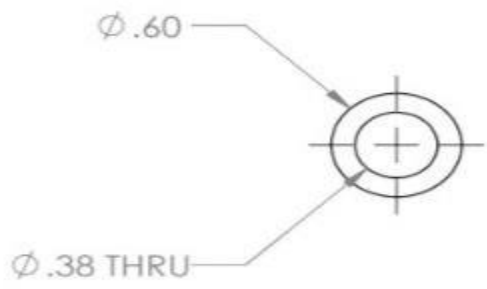
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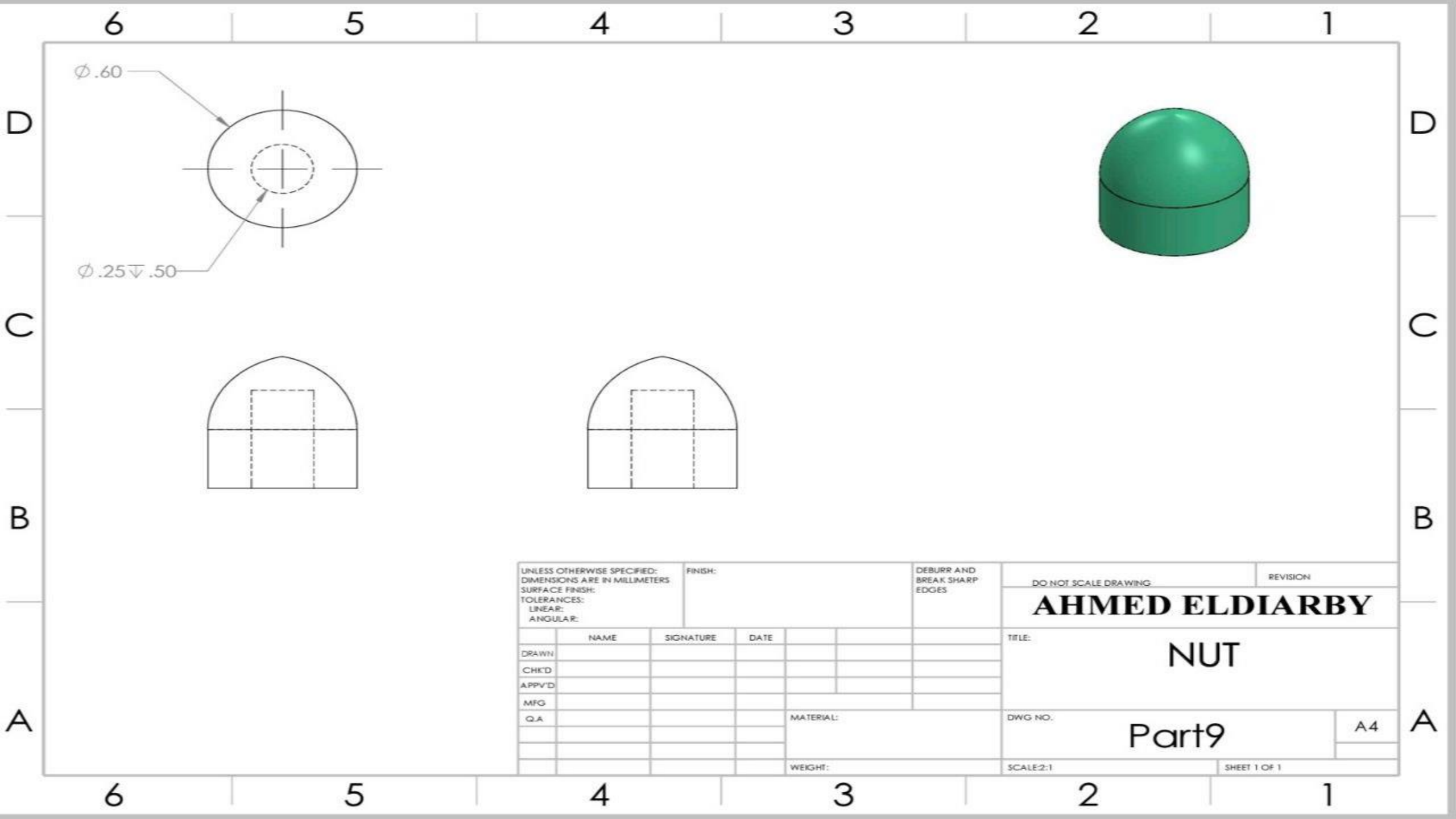
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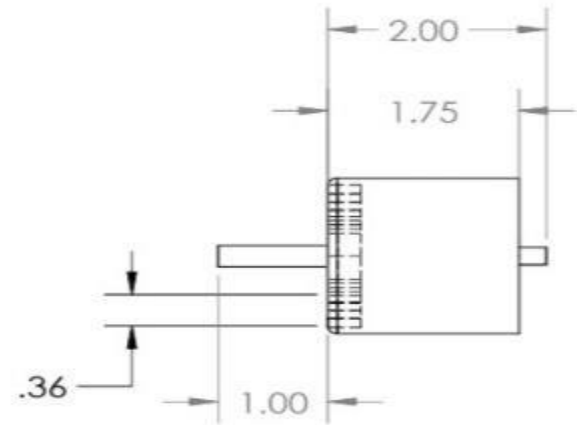
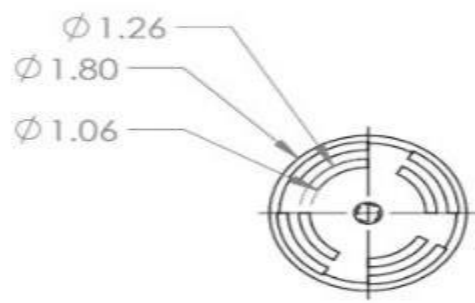
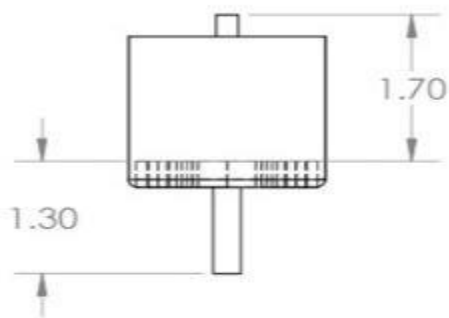
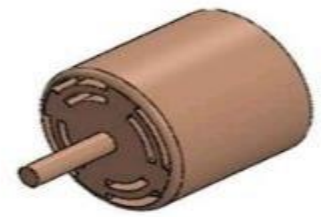
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