DECLARATION

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

Airfoils have become a combined aspect of human flight as it has evolved over the last century. As the design of each airfoil determines many aspects of its use in the real world, all significant characteristics must be analyzed prior to implementation. The aerodynamic effects of pressure, drag, lift, and pitching moment were used to evaluate the behavior of the airfoil. In this work, pressure distribution and velocity distribution were recorded over the upper and lower surfaces of the airfoil and compared to theoretical values created by Aerofoil, a computer simulation package.

The airfoil shape is expressed analytically as a function of some design parameters. The NACA 4 digits are used with design parameters that control the camber and the thickness of the airfoil.

The work had been performed using symmetrical and nonsymmetrical airfoils. A NACA 0012 symmetrical airfoil with a 12% thickness to a chord ratio was analyzed to determine the lift, drag forces. A NACA 2412, NACA 4415 and NACA 9608 are nonsymmetrical airfoils. NACA 2412 airfoil have a maximum thickness of 12% with a camber of 2% located 40% back from the airfoil leading edge. NACA 4415 airfoil has a maximum thickness of 15% with a camber of 4% located 40% back from the airfoil leading edge. NACA 9608 airfoil has a maximum thickness of 8% with a camber of 9% located 60% back from the airfoil leading edge. All calculations were taken at a velocity 4 m/s.

The purpose of this work was to determine the velocity distribution, pressure coefficient, lift and drag characteristics of airfoils.

Keyword: Airfoils, pressure distribution, velocity distribution, lift, drag

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS USED

FLOW QUANTITY

ρ	density of air
P_∞	pressure in the free stream
P_L	Pressure lower airfoil surface
P_u	Pressure upper airfoil surface
U_∞	Free stream velocity
u_∞	Free stream velocity in x-direction
u	velocity distribution on the plate
$u(x, z)$	the velocity components in the rectangular coordinate in x-axis
v_∞	Free stream velocity in y-direction
w_∞	Free stream velocity in z-direction
W_∞	relative velocity of the airflow
$w(x, z)$	the velocity components in the rectangular coordinate in z-axis
ΔW	velocities on the upper and lower surfaces of the airfoil
q_∞	dynamic pressure of undisturbed flow
Γ	circulation
k	vortex density (vortex strength per unit length) or the circulation distribution

GEOMETRIC QUANTITY

A	area of the airfoil
A_p	plan form area
a	Radius of circular cylinder
b	wingspan or is the distance from one wingtip to the other wingtip of the airplane
c	chord length
h	Profile chamber
h/c	relative camber (camber ratio)

r_N	Nose radius
r_N/c	relative nose radius
t	maximum thickness
t/c	relative thickness (thickness ratio)
x	position along the chord from 0 to *c*
x_L	x coordinate of the lower airfoil surface
x_h	Maximum camber position
x_h/c	relative camber position
x_u	x coordinate of the upper airfoil surface
x_t	Maximum thickness position
x_t/c	relative thickness position
z	Rectangular coordinate: z =vertical axis
z_L	z coordinate of the lower airfoil surface
z_u	z coordinate of the upper airfoil surface
Z^s	Mean camber line coordinate
Z^t	Teardrop profile coordinate

AERODYNAMIC QUANTITY

ζ	Joukowsky transformation function
α	angle of attack
2τ	trailing edge angle
$F(z)$	complex stream function of the flow
$\bar{w}(z)$	Stream function
A_0	Fourier series coefficient
A_1	Fourier series coefficient
A_n	Fourier series coefficient
ar	aspect ratio
C	is constant obtained by the integration of mean camber line
D	drag force
h_0	Fourier series coefficient
h_1	Fourier series coefficient

k_1	is first standard distribution of the circulation
k_{11}	is the first normal distribution of the circulation
L	lifting force
M_a	pitching moment about a point distance a from the leading edge
M_{AC}	pitching moment of the aerodynamic centre
M_{LE}	pitching moment about the leading edge
M_x	pitching moment about a different point, distance x behind the leading edge
X	the location of the vortex element producing the velocity
X_0	the location where induced velocity is produced
x_{AC}	position of the aerodynamic centre be a distance **x** behind the leading edge
x '	Location of vortex strength at any point on chord
C_D	drag Coefficient
$C_{D,0}$	drag coefficient at zero lift
$C_{D,i}$	induced drag
C_L	lift Coefficient
C_{Ma}	pitching moment coefficient about a point distance a from the leading edge
C_{MAC}	pitching moment coefficient of the aerodynamic centre
C_{MLE}	pitching moment coefficient about the leading edge
C_{MX}	pitching moment coefficient about a different point, distance x behind the leading edge
C_p	pressure coefficient
C_{pl}	pressure coefficients on the lower surface
C_{pu}	pressure coefficients on the upper surface
C_X	force coefficients in the X directions
C_Z	force coefficients in the Z directions
K_{CP}	Fraction of the centre of pressure