Compound Helicopter – Individual Assignment 1

NAME: JEET GURBANI

ROLL NUMBER: 23B0023

Section 1:
Additional Assumptions & Data

1.1.1 Physics Assumptions/Data

- **Steady, incompressible flow assumed. Compressibility corrections applied using Prandtl-Glauert relations**
- **2D airfoil characteristics applied locally, No spanwise flow**
- **Tip losses approximated using Prandtl's corrections**

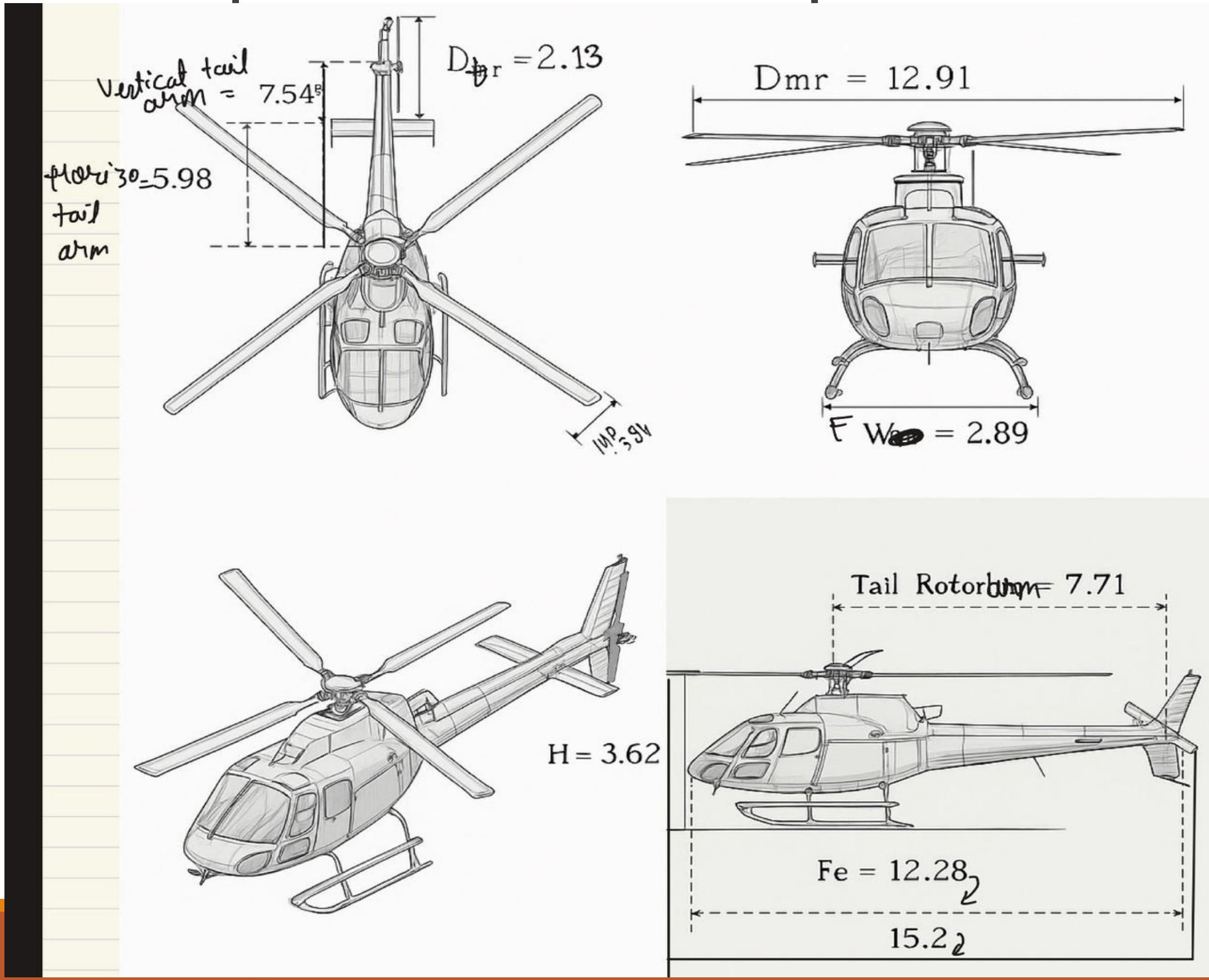
1.1.2 Environmental Assumptions/Data

- **International Standard Atmosphere (ISA) considered.**
- **Flight operations within Troposphere.**

1.1.3 Vehicle Assumptions/Data

- **Rotor geometry: 4 blades, Linear taper (taper ratio : 0.8), Linear twist (twist @ root = 5deg @tip = 0)**
- **Airfoil Aerodynamics data drawn from NACA 0015 Experimental results [1]**
- **Radius and rotor speeds are beeing claculated from statistical design**
- **Collective pitch is assumes at root for simplification**
- **other paramters of helicopter isfound using statistical design code**

1.2: Rough schematic sketch of own compound helicopter



all the values are in meters

these are the requirments for the copter

```
W_pl_target = 100
crew = 20
Rg_target = 600
rho_f = 0.8
V_max = 200
Nb = 4
Nb_tr = 2
taper_ratio = 0.8
twist_root = 3
twist_tip = 0
```

Helicopter Parameters Overview

Parameter	Value
Disc Loading (kg/m²)	35.46
Diameter (m)	15.38
Chord (m)	0.40
Tip Speed (m/s)	223.40
Angular Velocity (rad/s)	29.06

Main Rotor

Parameter	Value
Diameter (m)	2.13
Arm (m)	9.28
Tip Speed (m/s)	213.83
Angular Velocity (rad/s)	167.53
Chord (m)	0.27

Tail Rotor

Parameter	Value
Fuselage Length (m)	14.77
Rotor-to-Tail-End Length (m)	18.19
Helicopter Height (m)	4.08
Helicopter Width (m)	2.93
Horizontal Tail Arm (m)	6.96
Horizontal Tail Surface Area (m²)	1.37
Vertical Tail Arm (m)	8.97
Avg. Vertical Tail Chord (m)	0.82

Parameter	Value
Gross Weight (kg)	5175.17
Useful Weight (kg)	2319.34
Fuel Weight (kg)	819.34
Empty Weight (kg)	2855.84

Parameter	Value (kW)
Take-off Power (P_to)	1372.13
Take-off Transmission (T_to)	1147.97
Main Continuous Power (P_mc)	1032.87
Main Continuous Transmission (T_mc)	724.21

Parameter	Value
Never Exceed Speed (m/s)	221.05
Long Range Speed (m/s)	176.31

Section 2:
Preliminary Drone Design

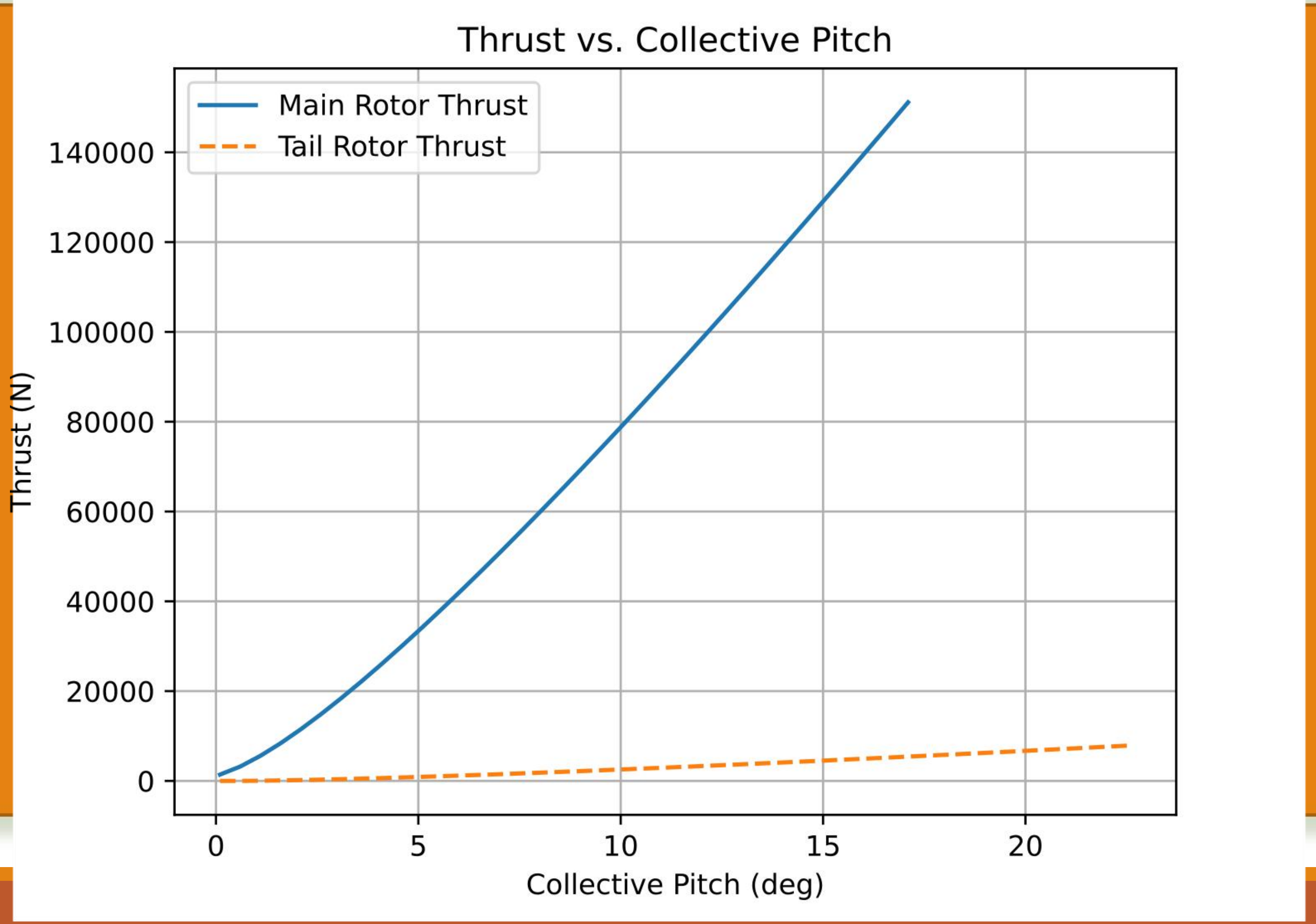
2.1: Design Parameters of your Design

Parameter	Rotor 1	Rotor 2
Rotor Description (role)	**Main rotor**	**tail rotor**
Airfoil	NACA 0015	NACA 0015
Rotor Radius (m)	**7.69**	**1.065**
Rotor tip Speed (m/s)	223.40	213.83
Number of Blades	**4**	**2**
Chord Length Variation	**linear taper ratio = 0.8**	**taper ratio =1**
Twist Variation	twist @ root = 3deg @tip = 0)	**no twist**
Root Cutout	**0.05*Radius**	**0.05*Radius**

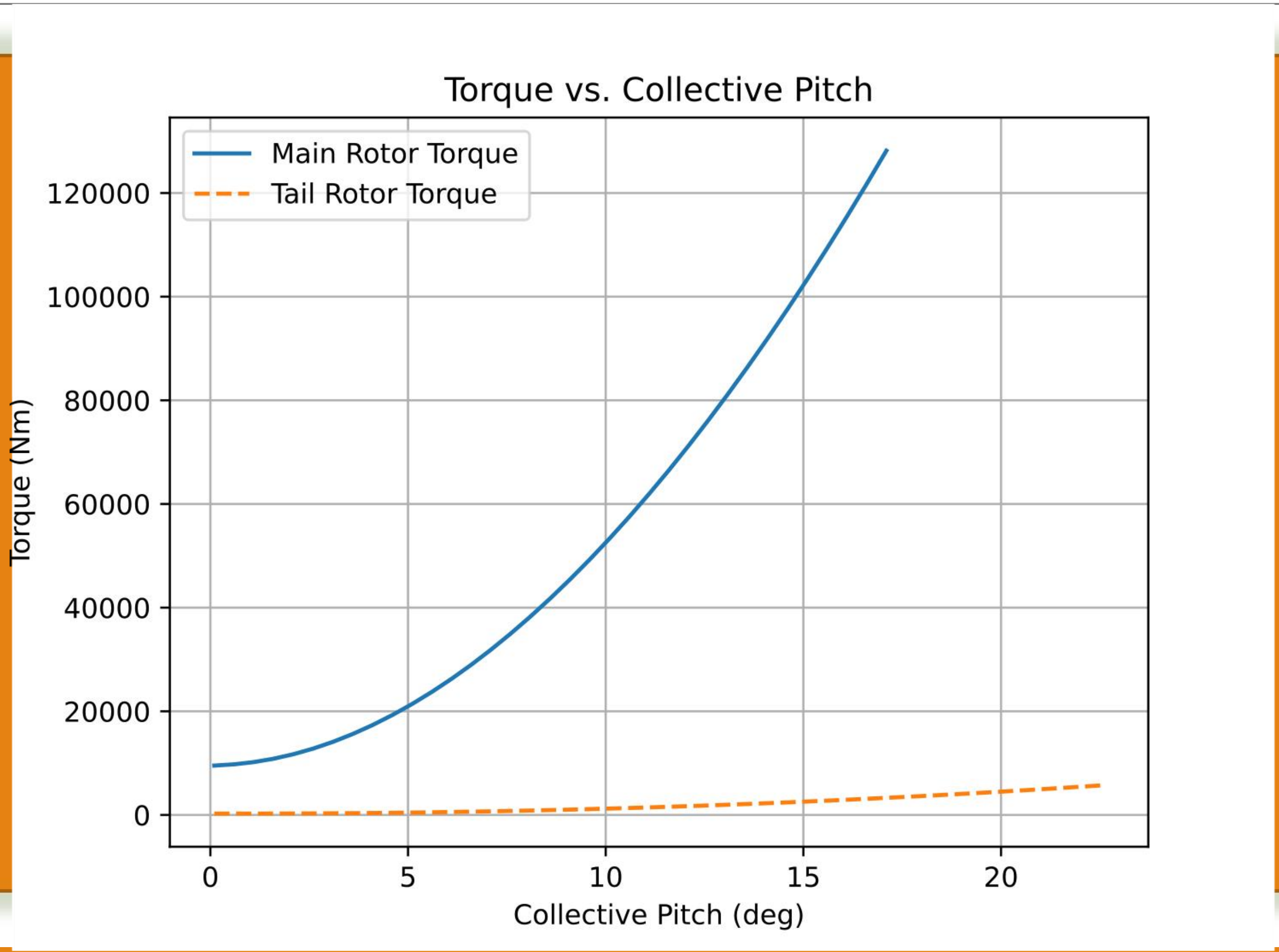
		Main	Tail
2.2	Maximum main and tail rotor thrusts before stall	162868.44	7845.62

```
--- 2.2: Maximum Thrusts Before Stall ---
Stalling at 18.30 deg, alpha = 12.01 deg.
Stall pitch for main rotor found at 18.30 deg max_alpha = 12.01 deg
Maximum Main Rotor Thrust before stall: 162868.44 N at pitch 18.30 deg
Stalling at 22.60 deg, alpha = 12.05 deg.
Stall pitch for tail rotor found at 22.60 deg max_alpha = 12.05 deg
Maximum Tail Rotor Thrust before stall: 7845.62 N at pitch 22.60 deg
```

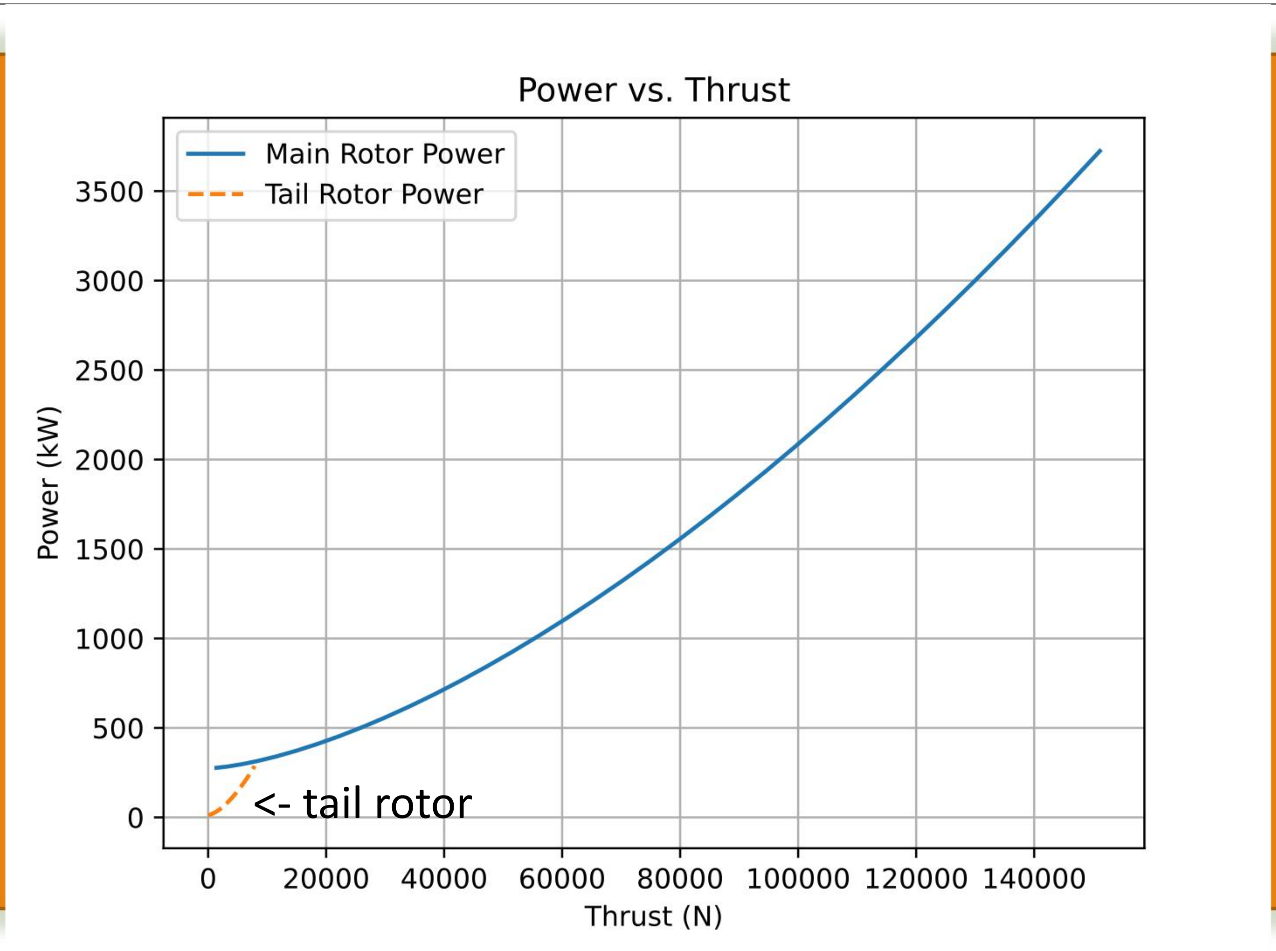
2.3.1: Thrust vs θ plots



2.3.2: Torque vs θ plots



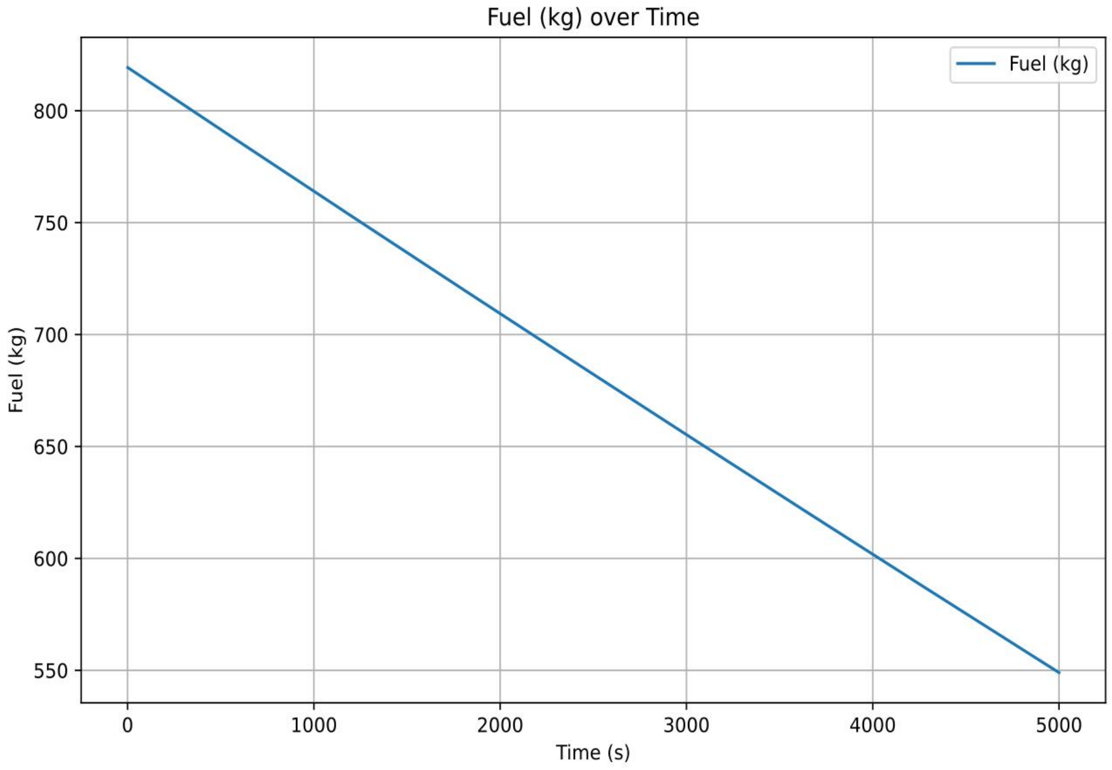
2.3.3: Thrust vs Power plots

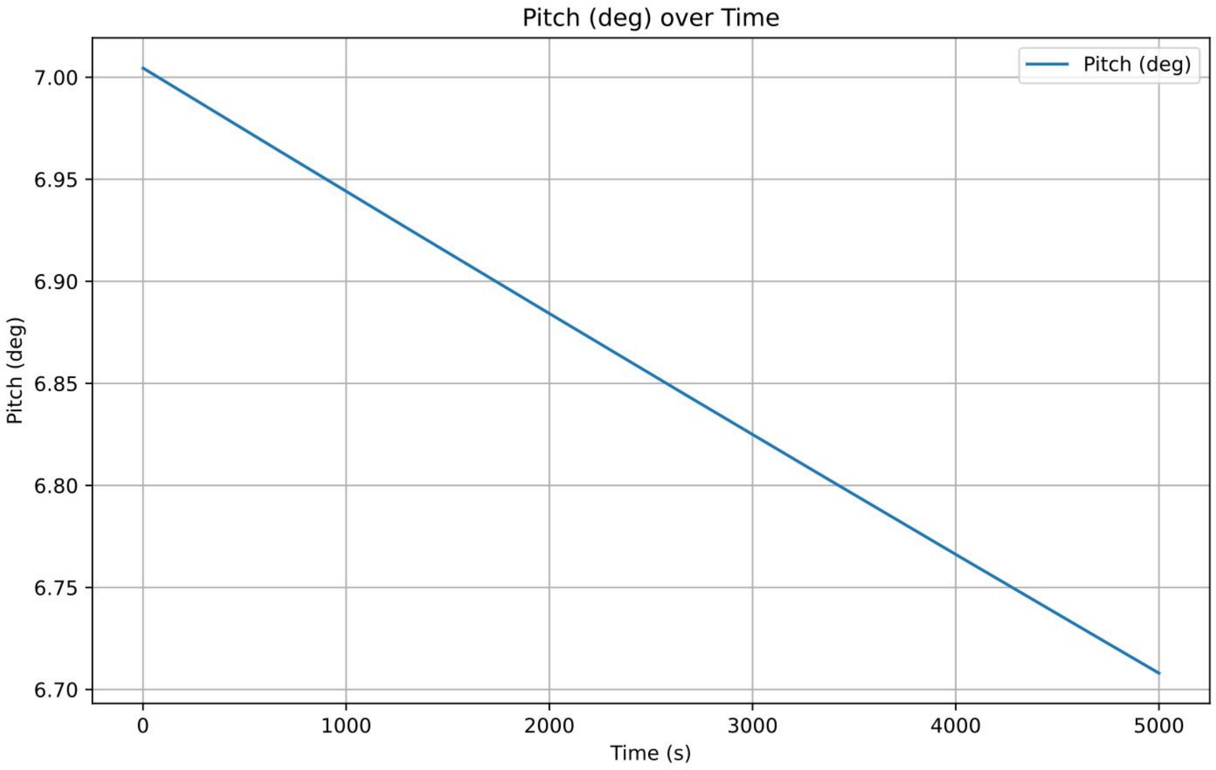


Section 3:
Hover Mission Test

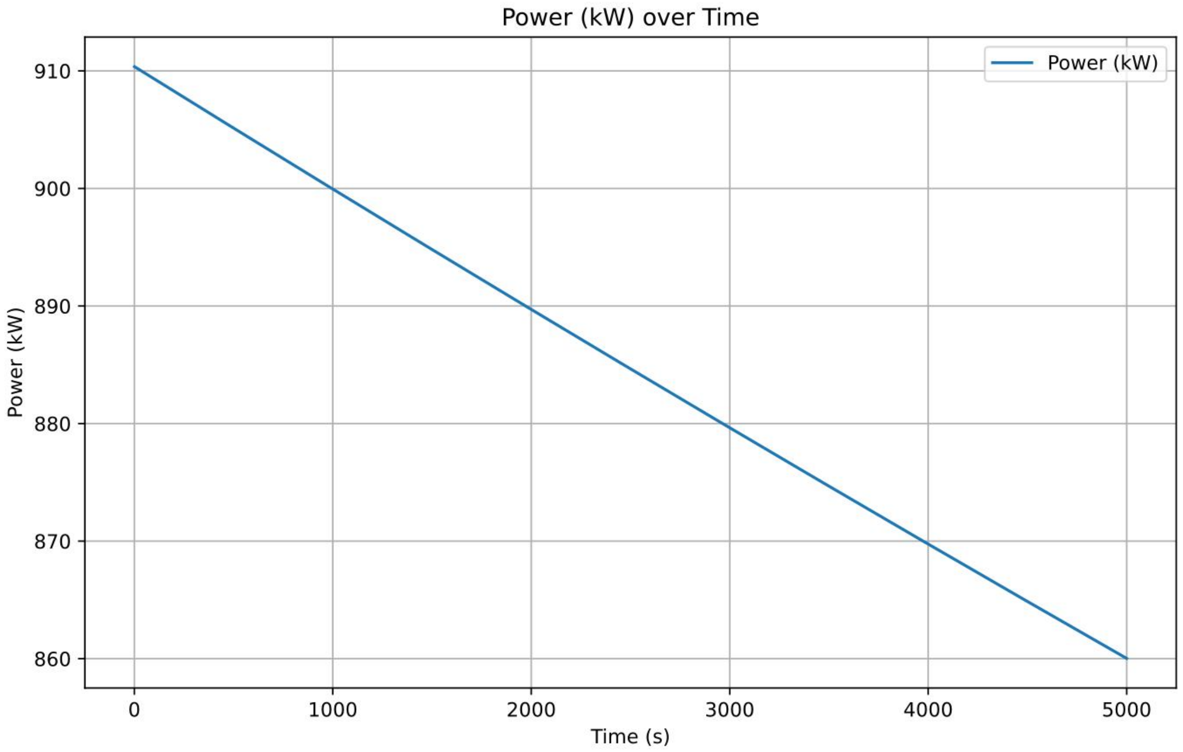
Mission plots

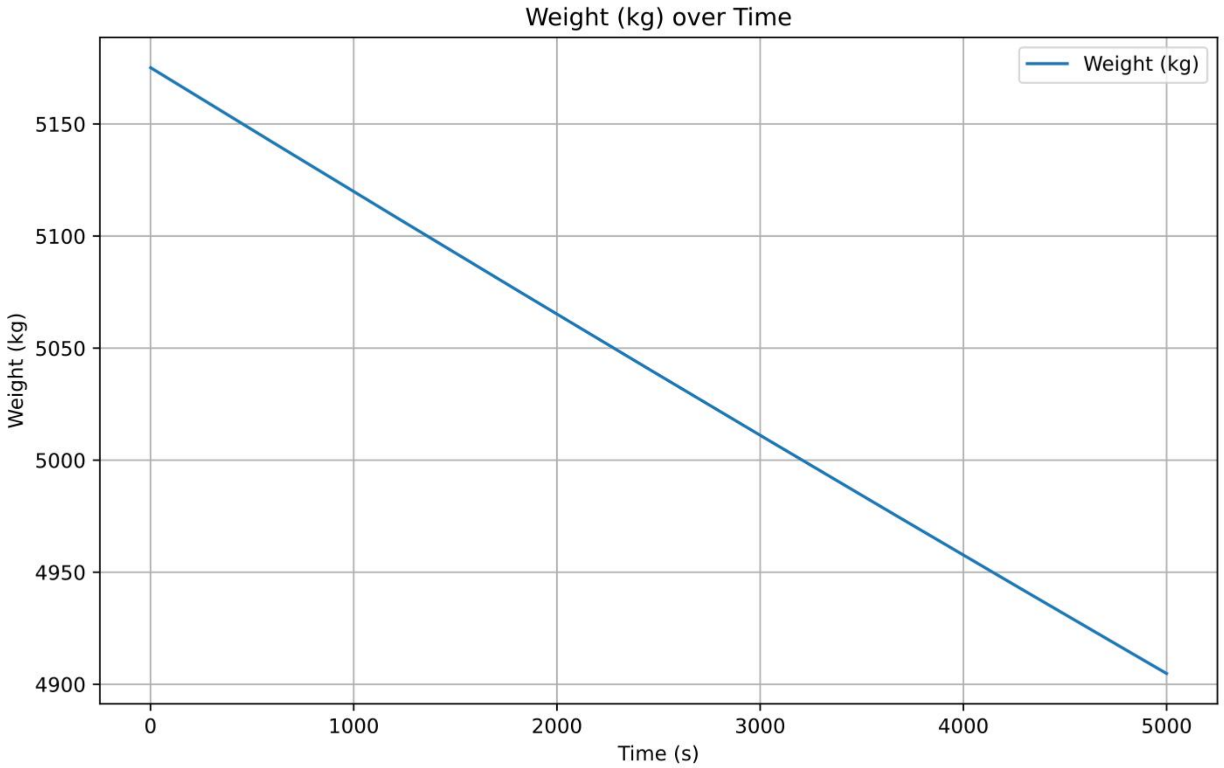
mission: hover on sea level for 5000 sec





Mission plots



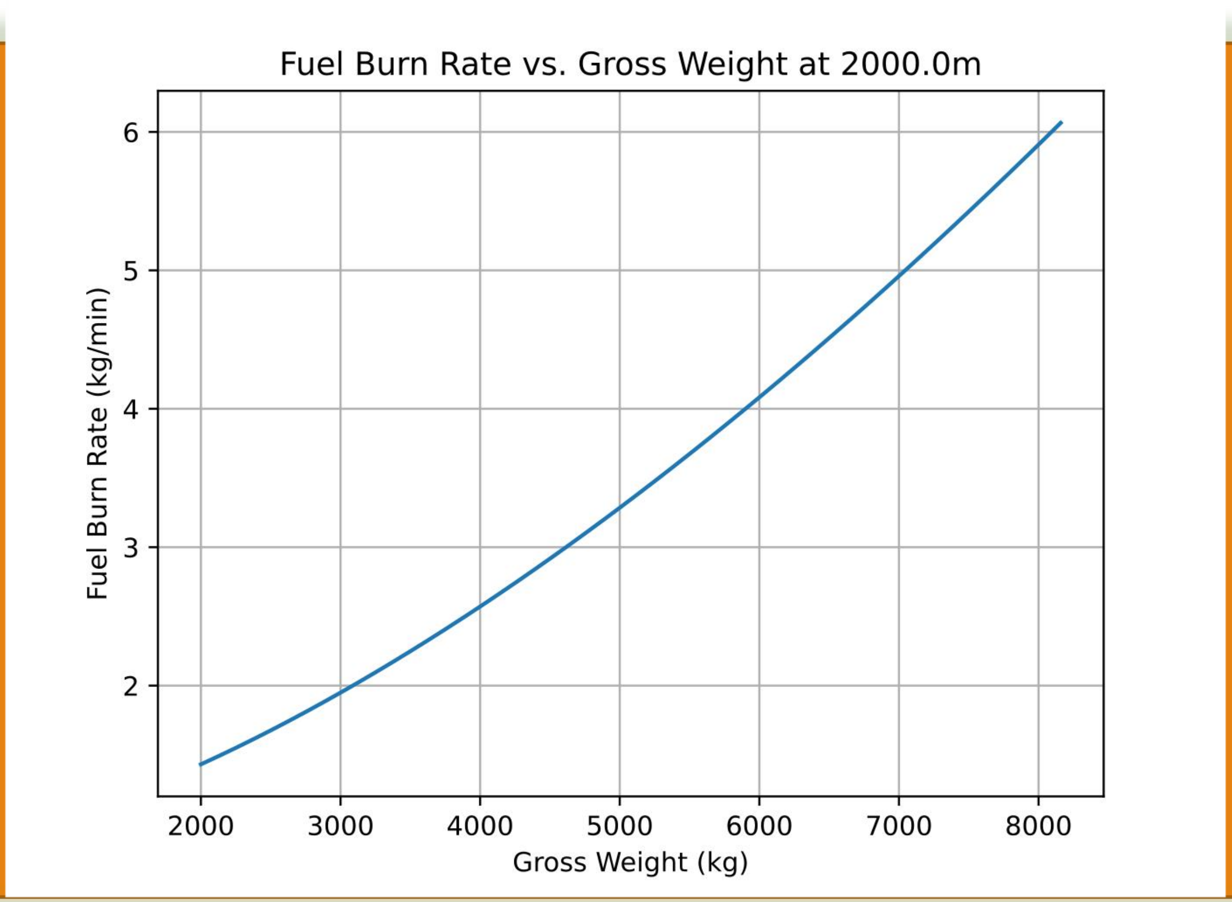


	Plots	Value
3.1	Maximum Take Off Weight based on blade stall at 2000 m AMSL	13665.98
3.2	Maximum Take Off Weight based on power requirement at 2000 m AMSL	8158

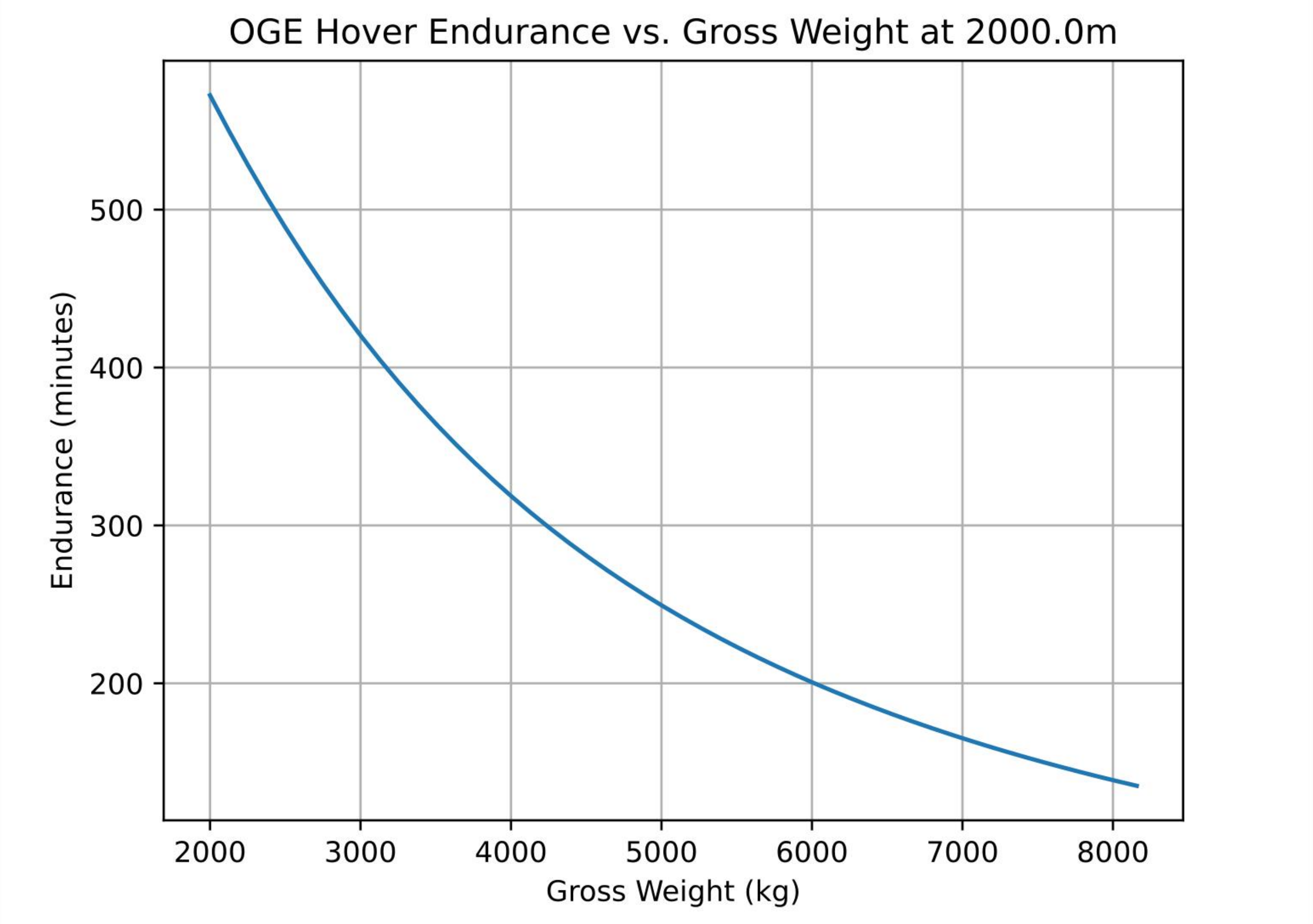
```
--- 3.1: Max Take-off Weight based on blade stall at 2000m AMSL ---
Stalling at 18.30 deg, alpha = 12.01 deg.
Stall pitch for main rotor found at 18.30 deg max_alpha = 12.01 deg
Maximum Take-Off Weight (Stall) at 2000.0m AMSL: 13665.98 kg
```

```
--- 3.2: Max Take-off Weight based on power requirement at 2000m AMSL ---
Maximum Take-Off Weight (Power) at 2000.0m AMSL: 8158.35 kg
```

3.3: Fuel Burn Rate (kg/minute) vs Gross Weight (kgf) Plot



3.4: OGE Hover Endurance (minutes) vs Take-Off-Weight (kgf) plot



Section 4:
Bonus Task: Flight Simulator Development

4.1: Placement of Components & C.G w.r.t nose

Component	X	Y	Z
Assumed C.G			
Rotor 1			
Rotor 2			
Rotor…			
Wing/Stabilizer - 1			
Wing/Stabilizer - 2			
Actuator – 1			
Actuator – 2			

4.2: Algorithm of the Simulator

4.3: Video Clip of Flight Simulator

4.4: Observations from Simulations

Comments / Observations
• • • …

Acknowledgement

< Mandatory to acknowledge people you discussed with or took help for any part of the assignment>

References

< List all references (books, paper, websites, etc.) used while doing the assignment>