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Declaration

**Here I promise that the whole assignment is done   
by myself alone without help from others.**

Individual data

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
| 0,024 | 0,065 | 10 | 800 | 20 | 0.25 |

Fundamentals of Flight

Assignment 4

**Task 1:**

In this task I calculated the maximum rate of climb and the corresponding climb angle depends on altitude. The maximum rate of climb of an airplane with propeller propulsion is given by following equations.

Since I assume the engine power is proportional to the density in the surrounding atmosphere, I shall have the following result.

The maximum climb angle is given by:

Then I shall get the following table.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| 0 | 12,79 | 21,28 | 35,23 |
| 500 | 11,95 | 19,34 | 36,09 |
| 1000 | 11,15 | 17,54 | 36,98 |
| 1500 | 10,36 | 15,86 | 37,91 |
| 2000 | 9,60 | 14,30 | 38,87 |

**Task 2:**

The time need for the airplane to climb a certain altitude is given by following integral.

I want to climb from altitude to the altitude so our integral will be .

I assume that each time the airplane climbs a height , the horizontal range increases with . Then it is easy to know that in this model. This gives that . I integrate this then I will get the total change in vertical range.

By using these expressions and the function in Matlab I can easily get the results. The total climbing time is and the horizontal range the airplane travelled is .

**Task 3:**

In this task I shall calculate the same thing but with a different model, i.e. speed now is then the Carson speed. The equations will become:

Then I have the following results.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| 0 | 10,43 | 9,85 | 61,02 |
| 500 | 9,54 | 8,78 | 62,51 |
| 1000 | 8,68 | 7,78 | 64,05 |
| 1500 | 7,83 | 6,85 | 65,66 |
| 2000 | 7,00 | 5,97 | 67,32 |

The total climbing time is and the horizontal range the airplane travelled is .

**Task 4:**

In this task I shall calculate the fuel consumption of those previous two climbing alternatives. The fuel consumption is given by the following equation.

Here m is the initial mass of the airplane which is and is the final mass of the airplane after climbing. To calculate the fuel consumption, I use the mean value for climb angle. So in the first mission the mean climb angle is and in the second mission the mean climb angle is then .

While we calculate with the maximum climb rate I shall have and when we are using the Carson speed I shall .

With these expressions we can calculate fuel consumptions. In the mission 1 I calculated that the fuel consumption is and the ratio . In the mission 2 I calculated that the fuel consumption is and the ratio .

**Task 5:**

In this task the fuel consumption is calculated given that the airplane shall travel totally . From task 1 we know that the airplane has flied in the climbing section so the range left is then .

The airplane is going to fly in a constant velocity and constant flight program. So the range the airplane has flied can be calculated by the following equation.

Because in the mission 1 the airplane is cruising with the speed giving minimum thrust, the lift-to-drag ratio is then the one that gives the maximum flight range, i.e. . So the weight ratio can be calculated by the following equation.

The total fuel mass is just the difference of and , .

The endurance corresponding to this flight mission is then.

Since the altitude is increasing so the final altitude can be given by the density changes, .

With these equations the following results are calculated. The range left is . The weight ratio . The total fuel mass used in cruising segment is . The endurance is . The final altitude is .

**Task 6:**

In this task I shall do the exact same thing as the task 5 but with the Carson speed. The expression that describe the fuel consumption is the same but with a different lift-to-drag ratio. The lift-to-drag ratio now is the one that maximize the ratio according to the definition of the Carson speed. This gives that . Everything else is the same.

So we shall get the following results. The range left is . The weight ratio . The total fuel mass used in cruising segment is . The endurance is . The final altitude is .

**Task 7:**

In this task the ratios is calculated at the beginning and ending of the cruising segment for both missions.

The power available is the maximum power the engine can give at a certain altitude.

The power required is the power that counter the drag.

With these equations the following results are calculated.

The power ratio at the beginning of the cruising in the first mission is , at the end of the cruising is . The power ratio at the beginning of the cruising in the second mission is 0,3721, at the end of the cruising is . The values at the beginning respect the ending differs very little. I believe this is because of that the weight ratio is too little to make a difference.

**Task 8:**

In this task the landing segment of mission 1 is studied. The landing start with a gliding segment with thrust down to altitude . The minimum glide angle and equilibrium glide velocity is given by the following equation.

So the horizontal is calculated easily. . The time spend on the glide landing segment is given by this equation.

So the results are in the following table.

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 2355 | 4,52 | 51,07929 |
| 2000 | 4,52 | 50,17027 |
| 1500 | 4,52 | 48,93166 |
| 1000 | 4,52 | 47,73748 |
| 500 | 4,52 | 46,58565 |

The horizontal range of this segment is then and the time spend on this segment is .

**Task 9:**

In this task I shall calculate the parameters that describe this final powered landing segment. These parameters are given by the following equations.

The results shall be given by these equations and is showed here in this table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
| 500 | 46,59 | 0,6088 | 5,8489 | 5,5159 | 53,24 | 0,2662 |
| 400 | 44,15 | 0,6713 | 6,1423 | 4,8673 | 46,98 | 0,2349 |
| 300 | 41,71 | 0,7448 | 6,4174 | 4,3080 | 41,58 | 0,2079 |
| 200 | 39,28 | 0,8320 | 6,6562 | 3,8371 | 37,04 | 0,1852 |
| 100 | 36,84 | 0,9366 | 6,8355 | 3,4541 | 33,34 | 0,1667 |
| 0 | 34,40 | 1,0636 | 6,9276 | 3,1588 | 30,49 | 0,1524 |

The range flied and the time the airplane spend on landing can be calculated with the same integrate methods above. I get the result that the horizontal range the airplane flied is and the time spend on landing is .