Escola Tècnica Superior d'Enginyeries Industrial i Aeronàutica de Terrassa
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Grau: *Grau en Enginyeria en Vehicles Aeroespacials*

Curs: Treball final de grau

Títol del projecte:

Estudi de viabilitat de l'ús d'ales volants com a transport comercial

Continguts: Annex B. Codi de MATLAB per al dimensionat inicial.

Estudiant: Alba Freixa Barat

Director del treball: Daniel Garcia Almiñana

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Codi de MATLAB per al dimensionat inicial

```
%--------------------------------------------------------------------
                       INITIAL SIZING
%--------------------------------------------------------------------

% GENERAL DATA INPUT

    R=11000;                     % Range [km]
                            % Endurance [h]
    E_L= 45;                        %45 min loiter
    Vc=250;                     % Cruise speed [m/s]
    h=36091;                     % Cruise height [ft]

    A=4.5;                      % Aspect ratio
    e=0.85;                      % Global Aerodynamic Efficiency
    Cd0=0.025;                   % Coefficient of friction
    alfa=0.027;                 % Second climb angle [rad]
    E_MAX=27;
    E_R=0.9*E_MAX;                     % Typical efficiency in cruise
cond.
    E_E=27;                     % Typical efficiency in loiter cond.

    % CONSTANTS

    ft=0.3048;
    lb=0.4535924;



% DESIGN TOW (Take-Off Weight) BREAKTHROUGH:

% W_TOW=W_CREW+W_PL+W_BEW+W_F [kg]

% W_CREW : Cabin Crew Weight
% W_PL : Payload Weight (PAX & Cargo)
% W_BEW : Basic Empty Weight
% W_F : Fuel Weight

    % DATA INPUT

        % W_TOW INITIAL GUESS

            W_TOW=500000;    % [kg]

        % W_CREW

            N_crew=12;        % Number of cabin crew
            W_avg_crew=110;   % Average crew weight (crew member &
their luggage) [kg]

        % W_PL

            N_PAX=300;        % Number of passengers
            W_avg_PAX=110;    % Average passenger weight (person &
luggage) [kg]
```

```
% W_F

            c=17.1e-6;                % Propeller specific fuel
consumption [kg/Ws]
            R10=0.990;                  % Mass ratio during start-up
            R21=0.995;                  % Mass ratio during taxi
            R32=0.980;                  % Mass ratio during take-off
            R43=0.980;                  % Mass ratio during climb
            R65=0.990;                  % Mass ratio during decent
            R87=0.995;                  % Mass ratio landing, taxi,
shut-down

    % W_TOW COMPUTING

       W_PL=N_PAX*W_avg_PAX;

        % MISSION SEGMENTS

            % 0-1: TAKE-OFF             => R01=W1/W_TOW
            % 1-2: CLIMBING             => R12=W2/W1
            % 2-3: CRUISE               => R23=W3/W2
            % 3-4: LOITER               => R34=W4/W3
            % 4-5: DESCENT & LANDING    => R45=W5/W4

            R54=exp(-c*9.81*R*1000/(E_R*Vc));
            R76=exp(-c*9.81*E_L*60/(E_R));
            R98=exp(-c*9.81*500*1000/(E_R*Vc));



            W_F=R10*R21*R32*R43*R54*R65*R76*R87*R98;

            delta=1;
            first=true;
            error=0;

            while (error>delta || first==true)
                first=false;
                W_OEW=0.5226*W_TOW;
                W_F=R10*R21*R32*R43*R54*R65*R76*R87*R98;
                W_TOW_old=W_TOW;
                W_TOW=W_PL+((1-W_F)*W_TOW)+(W_OEW);
                error=abs(W_TOW_old-W_TOW);
                W_TOW=W_TOW_old+0.5*(W_TOW-W_TOW_old);

            end

           W_TOW
           W_OEW
           W_MF=(1-W_F)*W_TOW
           W_BEW=W_OEW-(N_crew*W_avg_crew)
```

```
%-----------------------------------------------------------------------
-----
%                        DESIGN POINT SELECTION
%-----------------------------------------------------------------------
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    % CRUISE

        r_T=1/0.5;                                                    %
Thrust take-off/cruise ratio
        r_W=R10*R21*R32*R43;
% Weight cruise/take-off ratio
        ro_c=1.225*0.29;        % Cruise density [kg/m^3]
        q=0.5*ro_c*(Vc)^2;                                        %
Cruise dynamic pressure [Pa]

    % TAKE-OFF DISTANCE

        k_to=0.2470;                                 % Take-off
constant [m2/N]
        sigma_to=1;                                                   %
Density take-off/reference ratio
        s_to=2500;                                                     %
Take-off distance [m]

    % SECOND SEGMENT

        Ne=2;                                                         %
Number of engines
        r_T2=1;                                                       %
Thrust take-off/2ndseg ratio
        r_W2=R10*R21*R32;
% Weight 2ndseg/take-off ratio
        E_2=0.8*E_R;                                                  %
Second climb efficiency

    % LANDING DISTANCE

        k_l=1.225*0.189/1.69;
% Landing constant [kg/m2]
        sigma_l=1;                                                    %
Density landing/reference ratio
        r_W_l=1/(R10*R21*R32*R43*R54*R65*R76);
% Weight take-off/landing ratio
        s_l=2500;                                                      %
Landing distance [m]

 Wing_load=150:1:400;
 Pow_load_c=9.81*((((r_W)^(-
2))*r_T.*q./(9.81*Wing_load)).*(Cd0+(9.81*Wing_load.*r_W).^2./(q^2*pi*
A*e)));


 plot(Wing_load,Pow_load_c,'y','LineWidth',1);
 title('Selecció del punt de disseny');
 xlabel('Càrrega alar [kg/m^2]');
 ylabel('Ràtio impuls-pes [N/kg]');
```

```
hold on;

 for Cl_m_to=1.4

Pow_load_to=(9.81*k_to).*Wing_load*9.81/(sigma_to.*Cl_m_to.*s_to);
    plot(Wing_load,Pow_load_to,'b','LineWidth',1);
    hold on;

 end

 for Cl_m_l=1.4

    Pow_load_l=0:0.01:4.5;
    Wing_load=(0.8808/9.81)*sigma_l.*Cl_m_l.*s_l*r_W_l
    plot(Wing_load,Pow_load_l,'g','LineWidth',1);
    hold on;

 end

Wing_load=150:1:400;
Pow_load_2nd=9.81*(Ne/(Ne-1))*r_T2*r_W2*((E_2^(-1))+alfa);

plot(Wing_load,Pow_load_2nd,'r','LineWidth',1);

plot(367,3.2,'.k','LineWidth',5);
```