```
clc;
clear all;
close all;

%Raw data
%Ignoring last two data points due to experiment malfunction
rpm = [46500 49300 55000 60000 65100 70500];
Tm2 = [21.559 20.9850 21.1541 21.2047 20.8731 20.9066] + 273.15; %Cross flow
Tm3 = [68.5792 74.8547 86.1913 117.9889 129.9338 148.9507 171.9082]...
    + 273.15; %Cross flow
Tm4 = [503.7978 501.4857 509.7827 535.9689 547.0686 597.3990]...
    + 273.15; %Cross flow
Tm5 = [484.6335 474.2929 482.9551 507.9552 513.6135 556.9158]...
    + 273.15; %Axial flow
Tm8 = [488.5296 484.472 486.4055 494.6287 500.1043 514.3652]...
    + 273.15; %Cross flow
Tm_oil = [45.6508 49.6376 57.1879 64.9292 70.94 75.7677] + 273.15;
dp2 = [0.5141 0.6161 0.8152 1.0346 1.3044 1.6022] * 10^3; %Differential
pt3 = [50.4636 57.6214 73.4094 89.7863 109.6062 132.8239] * 10^3; %Stagnation
p4 = [46.6808 53.9519 69.468 85.8223 105.2571 128.2483] * 10^3; %Static
pt5 = [5.4178 6.1699 7.9933 10.2856 12.6753 15.7876] * 10^3; %Stagnation
pt8 = [3.5038 4.2604 5.9569 7.7169 9.3909 11.2959] * 10^3; %Stagnation
m_dot_fuel = [0.0021 0.0023 0.0025 0.0027 0.0029 0.0032]; %kg/s
thrust = [3.7 3.9 5.1 6 6.5 7.9] * 4.4482216; %N

rpm = rpm(6);
Tm2 = Tm2(6);
Tm3 = Tm3(6);
Tm4 = Tm4(6);
Tm5 = Tm5(6);
Tm8 = Tm8(6);
dp2 = dp2(6);
pt3 = pt3(6);
p4 = p4(6);
pt5 = pt5(6);
pt8 = pt8(6);
m_dot_fuel = m_dot_fuel(6);
thrust = thrust(6);

Po2 = 101.3 * 10^3; % Pa

%Convert pressures from gauge to absolute
pt3 = pt3 + Po2;
p4 = p4 + Po2;
pt5 = pt5 + Po2;
pt8 = pt8 + Po2;

%Given/known information
A1 = 27.3 * 0.00064516;
A2 = 6.4 * 0.00064516;
A3 = 9 * 0.00064516;
A4 = 7.2 * 0.00064516;
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A5 = 4.7 * 0.00064516;
A8 = 3.87 * 0.00064516;
RF_c = 0.68;
RF_a = 0.86;

%Time to actually find air m_dot, Ma, U, and rho at state 2
%Assumption - since Ma will be small, T2 = T2_measured ~= T2_actual
[~, ~, k, R] = sp_heats(Tm2, 'air');
Po2_over_P = Po2 ./ (Po2 - dp2);
Ma_2 = sqrt((Po2_over_P.^((k - 1) ./ k) - 1) .* (2 ./ (k - 1)));
U_2 = sqrt(k .* R .* Tm2) .* Ma_2;
rho_2 = (Po2 - dp2) ./ (R .* Tm2);
m_dot = rho_2 .* U_2 .* A2;

%Calculate air-fuel ratio
af = m_dot ./ m_dot_fuel;

%Define LHV
LHV = (42800 * 10^3) * 170.145/1000; %converted to J/mol

MM.O2 = 32;
MM.N2 = 28.02;
MM.C = 12.01;
MM.H = 1.008;
MM.H2O = 18.016;
MM.CO2 = 44.01;
MM.JetA = 170.145;

%stochiometric air fuel and equivalence ratio
AF_s = (17.85 * MM.O2 + 17.85*(79/21) * MM.N2) / (12.3 * MM.C + 22.2 * MM.H);
phi = AF_s ./ af

for i=1:length(rpm)
    [Ma2(i), To2(i), T2(i), Po2_ratio(i)] = ...
        zachStuart(Tm2(i), Po2, m_dot(i), A2, RF_c, 'air');
    [Ma3(i), To3(i), T3(i), Po3_ratio(i)] = ...
        zachStuart(Tm3(i), pt3(i), m_dot(i), A3, RF_c, 'air');
    %assume static = stagnation pressure at station 4 due to low Ma
    [Ma4(i), To4(i), T4(i), Po4_ratio(i)] = ...
        viggyFresh(Tm4(i), p4(i), m_dot(i) + m_dot_fuel(i), A4, RF_c, phi(i), MM);
    [Ma5(i), To5(i), T5(i), Po5_ratio(i)] = ...
        viggyFresh(Tm5(i), pt5(i), m_dot(i) + m_dot_fuel(i), A5, RF_a, phi(i), MM)
    [Ma8(i), To8(i), T8(i), Po8_ratio(i)] = ...
        viggyFresh(Tm8(i), pt8(i), m_dot(i) + m_dot_fuel(i), A8, RF_c, phi(i), MM)
end

%Find station 1 values
Po1 = Po2;
To1 = To2;
for i = 1:length(rpm)
    [Ma1(i), T1(i), Po1_ratio(i)] = richieTran(To1(i), Po1, m_dot(i), A1);
end

%Recalculate To4 with JetA chemistry things (Part 3)
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for i=1:length(rpm)
    To4_JetA(i) = combustor(MM, phi(i), To3(i));
end

%Calcualate To5s_JetA using To4_JetA
To5s_JetA = turb_Ts(To4_JetA, (pt5 ./ p4), length(rpm), 'JetA', phi, MM);

%Calculate speed of sound at each station
[~, ~, gamma1, ~] = sp_heats(T1, 'air');
[~, ~, gamma2, ~] = sp_heats(T2, 'air');
[~, ~, gamma3, ~] = sp_heats(T3, 'air');
[~, ~, gamma4, ~] = sp_heats_JetA(T4, phi, MM);
[~, ~, gamma5, ~] = sp_heats_JetA(T5, phi, MM);
[~, ~, gamma8, ~] = sp_heats_JetA(T8, phi, MM);

U1 = Ma1 .* sqrt(gamma1 .* R .* T1);
U2 = Ma2 .* sqrt(gamma2 .* R .* T2);
U3 = Ma3 .* sqrt(gamma3 .* R .* T3);
U4 = Ma4 .* sqrt(gamma4 .* R .* T4);
U5 = Ma5 .* sqrt(gamma5 .* R .* T5);
U8 = Ma8 .* sqrt(gamma8 .* R .* T8);

%Compute all static pressures from stagnation ratios
stag_two = ones(1, length(rpm)) * Po2;
P1 = stag_two ./ Po1_ratio;
P2 = stag_two ./ Po2_ratio;
P3 = pt3 ./ Po3_ratio;
P4 = p4./ Po4_ratio;
P5 = pt5 ./ Po5_ratio;
P8 = pt8 ./ Po8_ratio;

%Calculate thrust terms - CV from state 0 to state 8
Ft_calc = ((m_dot + m_dot_fuel) .* U8)
thrust_sp = Ft_calc ./ m_dot
TSFC = m_dot_fuel ./ Ft_calc

%Marker size var
markerSize = 10;

%Convert rpm tp krmp
krpm = rpm ./ 1000;

lhv = 42800 * 10^3; %J/kg
Q_dot = m_dot_fuel .* lhv;
W_net = (m_dot + m_dot_fuel) .* (U8 .^ 2)  ./ 2;
eta_therm = W_net ./ Q_dot

W_dot_comp_actual = m_dot .* deltaH_var_cp(To2, To3, length(rpm), ...
                    'air', phi, MM);
W_dot_turb_actual = (m_dot + m_dot_fuel) .* ...
                    deltaH_var_cp(To5, To4, length(rpm), 'JetA', phi, MM);

To3s = comp_Ts(To2,(pt3 ./ Po2), length(rpm), 'air', phi, MM);
eta_comp = deltaH_var_cp(To2, To3s, length(rpm), 'air', phi, MM) ...
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```
           ./ deltaH_var_cp(To2, To3, length(rpm), 'air', phi, MM)

To5s = turb_Ts(To4,(pt5 ./ p4), length(rpm), 'JetA', phi, MM);

eta_turb = deltaH_var_cp(To5, To4, length(rpm), 'JetA', phi, MM) ...
           ./ deltaH_var_cp(To5s, To4, length(rpm), 'JetA', phi, MM)

%Nozzle
T8s = jeannyWang(To5, pt5 ./ (ones(1, length(rpm)) .* Po2),...
                 length(rpm), 'JetA', phi, MM);
U8s = sqrt(2 .* deltaH_var_cp(T8s, To5, length(rpm), 'JetA', phi, MM));
eta_nozz = (U8.^2) ./ (U8s.^2)
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