```
clear all
clc

T04=857+273                 % Turbine inlet temperature
m=48                         % inlet mass rate
T06A=927+273                % max afterburner temperature
afterburner=0 ;              % 0 if afterburner not used, 1 if used
T_inf=220                   % ambient temperature
P_inf=0.25*101325           % ambient pressure
M_inf=0.85                  % flight mach number
gamma=1.4    ;               % ratio of specific heats
R=287  ;                     % gas constant
u=M_inf*sqrt(gamma*R*T_inf)     %  inlet velocity

Cp=gamma*R/(gamma-1) ;              % specific heat
prc=linspace(7.2, 7.2,1)            %  compressor pressure ratio

% isentropic efficiencies
e_diff=0.97 ;                   % inlet/diffuser
e_n_hot=0.98;                   % hot stream nozzle
e_comp=0.835;                   % compressor
e_turb=0.865;                   % turbine
e_burner=0.95;                  % burner/combustor
e_ab=0.5;                       % afterburner
del_p1=0.0;                     % burner pressure loss in %
del_p2=0;                      % afterburner pressure loss in %
Q=45000000 ;                    % fuel heat content


prc_critical= 1/(1-(gamma-1)/(e_n_hot*(gamma+1)))^(gamma/(gamma-1))   % to check if nozzle chokes or not

% diffuser stage
T02=T_inf*(1+(gamma-1)*0.5*M_inf^2)
P02=P_inf*(1+(T02/T_inf-1)*e_diff)^(gamma/(gamma-1))



for i=1:length(prc)

    f_ab(i)=0;                          % initializing the afterburner fuel fraction
    %  compressor stage
    P03(i)=(P02*prc(i))
    T03(i)=T02*(1+(prc(i)^((gamma-1)/gamma)-1)/e_comp)

    % burner fuel air ratio
    f(i)=(T04-T03(i))/(e_burner*Q/(Cp)-T04)

    % turbine inlet pressure
    P04(i)=(P03(i))*(1-del_p1)  % # given pressure loss is zero


    %  compressor turbine power balance
    T05(i)=T04-(T03(i)-T02)/0.99 %-B*(T08-T02);
    P05(i)=(P04(i)*(1-(1-T05(i)/T04)/e_turb)^(gamma/(gamma-1)))
    T06(i)=(T05(i))
    P06(i)=(P05(i))

    if afterburner==0                                     % if the afterburner is disabled
        if P_inf/P06(i) > 1/prc_critical                   % loops if nozzle doesn't choke
        v7(i)=(sqrt(2*e_n_hot*Cp*T06(i)*(1-(P_inf/P06(i))^((gamma-1)/gamma))))   % exit velocity, complete expansion to P_inf
           t(i)=(1+f(i))*v7(i)-u                          % unchoked thrust without afterburner
           s=(f(i))/t(i)                 % TSFC
           sprintf('no afterburner, nozzle does not choke ')
        else                                          % runs if nozzle chokes

        T7(i)=2*T05(i)/(gamma+1)                 % critical temperature
        v7(i)=(gamma*R*T7(i))^0.5                % exit choked velocity
        p7(i)=P06(i)/prc_critical                % critical pressure
        rho7(i)=P06(i)/(R*T7(i))                 % critical density at exit
        t(i)=(1+f(i))*v7(i)-u + (p7(i)-P_inf)/(rho7(i)*v7(i))   % choked thrust without afterburner

       s=(f(i))/t(i)    %TSFC
```

```
      sprintf('no afterburner, nozzle chokes, nozzle diameter -')
      d=2*sqrt(m/(rho7(i)*v7(i)*3.14))
       end


    else

        P_06(i)=P05(i)*(1-del_p2)        % loss in afterburner
        f_ab(i)=((1+f(i))*(T06A-T05(i)))/(e_ab*Q/Cp-T06A)    % fuel fraction in afterburner

        if P_inf/P06(i) >1/prc_critical                  % nozzle unchoked with afterburner

            v7(i)=(sqrt(2*e_n_hot*Cp*T06A*(1-(P_inf/P06(i))^((gamma-1)/gamma))))   % exit velocity, complete expansion to atmosphere
            t(i)=(1+f(i)+f_ab(i))*v7(i)-u                  % unchoked thrust with afterburner
            s=(f(i)+f_ab(i))/t(i)         %TSFC
            sprintf(' afterburner on, nozzle does not choke ')

        else                                     % nozzle choked with afterburner

        T7(i)=2*T06A/(gamma+1)                 % critical temperature
        p7(i)=P06(i)/prc_critical              % critical pressure
        v7(i)=(gamma*R*T7(i))^0.5              % critical choked velocity at exit
        rho7(i)=p7(i)/(R*T7(i))                % critical denstiy

        t(i)=(1+f(i)+f_ab(i))*v7(i)-u + (p7(i)-P_inf)/(rho7(i)*v7(i))    % choked thrust with afterburner
        s=(f(i)+f_ab(i))/t(i)              % TSFC
         sprintf(' afterburner on, nozzle chokes ')
          d=2*sqrt(m/(rho7(i)*v7(i)*3.14))
        end

    end
    e_prop(i)=2*t(i)*u/(t(i)*u*2+(1+f(i)+f_ab(i))*(v7(i)-u)^2)   % propulsive efficiency
    e_therm(i)=(t(i)*u*2+(1+f(i)+f_ab(i))*(v7(i)-u)^2)/(2*(f(i)+f_ab(i))*Q) %thermal efficiency

end

e_overall=e_prop.*e_therm
%hold on
thrust=t*m
 %   plot(prc,t)
 %   plot(prc,e_prop,'o')
 %   plot(prc,e_therm,'*' )
 %   plot(prc,e_prop.*e_therm,'+' )
 %   title('T_{04}=1630 K & B=0')
 %   xlabel('  Compressor pressure ratio \pi_C')
 %   ylabel('\eta')
```

```
T04 =

        1130


m =

    48


T06A =

        1200


T_inf =

   220


P_inf =

   2.5331e+04


M_inf =
```

```
    0.8500

u =

  252.7175

prc =

    7.2000

prc_critical =

    1.9202

T02 =

  251.7900

P02 =

   4.0091e+04

P03 =

   2.8865e+05

T03 =

  480.2796

f =

    0.0157

P04 =

   2.8865e+05

T05 =

  899.2024

P05 =

   1.1245e+05

T06 =

  899.2024

P06 =

   1.1245e+05

T7 =

  749.3354
```

```
v7 =

  548.7103


p7 =

   5.8561e+04


rho7 =

    0.5229


t =

  420.4179


s =

   3.7303e-05


ans =

no afterburner, nozzle chokes, nozzle diameter -


d =

    0.4617


e_prop =

    0.7048


e_therm =

    0.2136


e_overall =

    0.1505


thrust =

   2.0180e+04
```

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