**MAIN PROGRAM**

clear all;

global RH RMIX R Y X MMIX;

RH=0;

Y=[0 0 0.21 0.79 RH 0];

M=[4.003 39.948 31.999 28.013 18.015 44.010]; %[He Ar O2 N2 H2O CO2]

R=[2.077 .208 .26 .297 .462 .189];

MMIX=M\*Y';%Calculate other mixture values

X=Y.\*M./MMIX;

RMIX=8.3145/MMIX;

Rv=15;

Ncomp=.866; Nturb=.885; Ngen=.985;

Vdotft3=290000;%ft^3/m

VdotAir=Vdotft3\*.028317/60;%m^3/s

MdotAir=(14.7/.14504)\*VdotAir/(RMIX\*(5/9\*(68+460)));%kg/s

LHVBTU=20960;%BTU/lbm

LHV=LHVBTU\*1.055\*2.2046;%kj/kg

MdotFuelLbm(1)=10000;

Load=[1 .9 .8 .7 .6 .5 .4 .3 .2];

for k=1:9

delWcycle(1)=10;

j=1;

MFa=0;

MFb=100000;

MdotFuelLbm(k)=Load(k)\*MdotFuelLbm(1);

while(abs(delWcycle(j))>=.01) & (j<100)

if k==1

MdotFuelLbm(k)=(MFa+MFb)/2;

end

MdotFuel=MdotFuelLbm(k)\*.45359/3600;%kg/s

%State 2

T2=59; P2(k)=14.7;

Temp2(k)=T2;

STATE2=values([T2 P2]);

K2=STATE2(4);

h2=STATE2(1);

%State 3

P3=Rv\*P2;

%Iterate to find value of T4

T3sa=T2;

T3sb=1000;

i=1;

deltaS(1)=1;

while(abs(deltaS(i))>=.001) & (i<10)

T3s=(T3sa+T3sb)/2;

STATE3s=values([T3s P3(k)]);

deltaS(i+1)=(STATE3s(3)-STATE2(3))-RMIX\*log(Rv);

if (deltaS(i+1) >= 0)

T3sb=T3s;

elseif (deltaS(i+1) < 0)

T3sa=T3s;

end

i=i+1;

end%Final T3s value is T3 in the isentropic case

h3s=STATE3s(1);

%Iterate to find actual T3 with isentropic efficiency

deltaH(1)=10;

i=1;

T3a=T3s;

T3b=1000;

while(abs(deltaH(i))>=1) & (i<10)

T3=(T3a+T3b)/2;

STATE3=values([T3 P3(k)]);

h3=STATE3(1);

deltaH(i+1)=Ncomp\*(h3-h2)-(h3s-h2);

if (deltaH(i+1) >= 0)

T3b=T3;

elseif (deltaH(i+1) < 0)

T3a=T3;

end

i=i+1;

end

h3=STATE3(1);

Temp3(k)=T3;

%State 4

P4=P3;

h4=(h3\*MdotAir+MdotFuel\*LHV)/MdotAir;

deltaH(1)=10;

i=1;

T4a=T3;

T4b=5000;

while(abs(deltaH(i))>=1) & (i<100)

T4=(T4b+T4a)/2;

STATE4=values([T4 P4]);

deltaH(i+1)=STATE4(1)-h4;

if (deltaH(i+1) >= 0)

T4b=T4;

elseif (deltaH(i+1) < 0)

T4a=T4;

end

i=i+1;

end

Temp4(k)=T4;

%State 5

P5=P2;

T5sa=T4;

T5sb=0;

i=1;

deltaS(1)=1;

while(abs(deltaS(i))>=.001) & (i<10)

T5s=(T5sa+T5sb)/2;

STATE5s=values([T5s P5]);

deltaS(i+1)=(STATE5s(3)-STATE4(3))-RMIX\*log(1/Rv);

if (deltaS(i+1) >= 0)

T5sa=T5s;

elseif (deltaS(i+1) < 0)

T5sb=T5s;

end

i=i+1;

end%Final T5s value is T5 in the isentropic case

h5s=STATE5s(1);

deltaH(1)=10;

i=1;

T5a=T5s;

T5b=T4;

while(abs(deltaH(i))>=1) & (i<100)

T5=(T5a+T5b)/2;

STATE5=values([T5 P3]);

h5=STATE5(1);

deltaH(i+1)=Nturb\*(h5s-h4)-(h5-h4);

if (deltaH(i+1) >= 0)

T5a=T5;

elseif (deltaH(i+1) < 0)

T5b=T5;

end

i=i+1;

end

h5=STATE5(1);

Temp5(k)=T5;

WTurbine=MdotAir\*(h4-h5);

WCompressor=MdotAir\*(h3-h2);

Wcycle(k)=(WTurbine-WCompressor)\*Ngen;

delWcycle(j+1)=Wcycle(k)-48000;

if (delWcycle(j+1) >= 0) & (k==1)

MFb=MdotFuelLbm;

elseif (delWcycle(j+1) < 0) & (k==1)

MFa=MdotFuelLbm;

else

delWcycle(j+1)=0;

end

j=j+1;

end

WTurbine=MdotAir\*(h4-h5);

WCompressor=MdotAir\*(h3-h2);

Wcycle(k)=(WTurbine-WCompressor)\*Ngen;

Nthermal(k)=Wcycle(k)/(MdotFuel\*LHV);

SFC(k)=MdotFuel/Wcycle(k);

HeatRate(k)=(MdotFuelLbm(k)\*LHVBTU)/Wcycle(k);

FiringTempF(k)=T4;

FiringTempK(k)=(T4+460)\*5/9;

end

figure(1);

plot(Load,Nthermal);

title('Load vs. Thermal Efficiency')

xlabel('Load(%)')

ylabel('Thermal Efficiency(%)')

figure(2);

plot(Load,MdotFuelLbm);

title('Load vs. Fuel Flow Rate')

xlabel('Load(%)')

ylabel('Fuel Flow Rate(Lbm/Hr)')

figure(3);

plot(Load,SFC);

title('Load vs. Specific Fuel Consumption')

xlabel('Load(%)')

ylabel('Specific Fuel Consumption(Lbm/kW-Hr)')

figure(4);

plot(Load,HeatRate);

title('Load vs. Heat Rate')

xlabel('Load(%)')

ylabel('Heat Rate(BTU/Lbm-Hr)')

figure(5);

plot(Load,FiringTempF);

title('Load vs. Firing Temperature')

xlabel('Load(%)')

ylabel('Firing Temperature(F)')

figure(6);

plot(Load,FiringTempK);

title('Load vs. Firing Temperature')

xlabel('Load(%)')

ylabel('Firing Temperature(K)')

TEMPS=[Temp2;Temp3;Temp4;Temp5];

PRESS=[P2;P3;P4;P5];

**FUNCTION ‘values’**

function y = values(x)%input parameter = [temp(F) pressure(psiA)]

%Stored reference values

global RH RMIX R Y X MMIX;

Sref=[31.5375 3.876 6.6999 6.8045 10.423 4.8585];

Uref=[928.419 92.976 194.2 221.44 412.05 156.57];

Href=[1547.365 154.96 271.72 309.99 549.75 212.93];

%Tabulated Cp and Cv values from table 5s

Cp5s=[1.0041 1.0107 1.0249 1.0452 1.0687 1.0927 1.1154 1.1360 1.1544 1.1706 1.1848 1.1973 1.2083 1.2180 1.2267 1.2345 1.2416 1.2480 1.2539 1.2593 1.2644];

Cv5s=[.7169 .7235 .7376 .758 .7815 .8054 .8281 .8488 .8672 .8834 .8976 .9101 .9210 .9308 .9395 .9473 .9544 .9608 .9667 .9721 .9771];

Pref=100;%in kPa

Tref=298;%in Kelvin

COEFF=[0 0 0 0;%Coefficients of Cp equations

0 0 0 0;

0.7963 4.7501e-004 -2.2360e-007 4.1001e-011;

1.0317 -5.6081e-005 2.8847e-007 -1.0256e-010;

1.7896 1.0674e-004 5.8562e-007 -1.9956e-010;

0.5058 0.0014 7.9550e-007 1.6971e-010];

CvCOEFF=COEFF;%Coefficients of Cv equations where Cv=Cp-R

CvCOEFF(3,1)=COEFF(3,1)-R(3);

CvCOEFF(4,1)=COEFF(4,1)-R(3);

CvCOEFF(5,1)=COEFF(5,1)-R(3);

CvCOEFF(6,1)=COEFF(6,1)-R(3);

sintCOEFF(:,1)=COEFF(:,1);%Divide each coefficient by its respective power for integration to find entropy

sintCOEFF(:,2)=COEFF(:,2);

sintCOEFF(:,3)=COEFF(:,3)/2;

sintCOEFF(:,4)=COEFF(:,4)/3;

intCOEFF(:,1)=COEFF(:,1);%Divide each coefficient by its respective power for integration to find h

intCOEFF(:,2)=COEFF(:,2)/2;

intCOEFF(:,3)=COEFF(:,3)/3;

intCOEFF(:,4)=COEFF(:,4)/4;

intCvCOEFF(:,1)=CvCOEFF(:,1);%Divide each coefficient by its respective power for integration to find u

intCvCOEFF(:,2)=CvCOEFF(:,2)/2;

intCvCOEFF(:,3)=CvCOEFF(:,3)/3;

intCvCOEFF(:,4)=CvCOEFF(:,4)/4;

hrefMIX=Href\*X';

urefMIX=Uref\*X';

srefMIX=Sref\*X';

%get values of mixture pressure and temperature

%disp 'Input the mixture Pressure(kPa) and Temperature(C):';

pressPSIA=x(2);%input('Pressure(PsiA): ');

pressKPA=pressPSIA/.14504;

tempF=x(1);%input('Temperature(F): ');

tempK=5/9\*(tempF+460);%Temperature F to K;

intCpMIXref=303.6432;%Constant integrated value of Cp at reference temperature (298K)

intCvMIXref=226.1387;%Constant integrated value of Cv at reference temperature (298K)

sMIXref=5.5924;%Constant integrated value of Cpdt/T at reference temperature (298K)

TEMPz=[tempK 298];

%calculate values of Cp and Cv, integrals of Cp and Cv, h, u and s

for i=1:2

temp=TEMPz(i);

TEMP=[1 temp temp^2 temp^3];

sTEMP=[log(temp) temp temp^2 temp^3];

Cp=COEFF\*TEMP';

Cp(1)=5/2\*R(1);

Cp(2)=5/2\*R(2);

Cp=COEFF\*TEMP';

s=sintCOEFF\*sTEMP';

s(1)=5/2\*R(1)\*log(temp);

s(2)=5/2\*R(2)\*log(temp);

intTEMP=temp\*TEMP;%Add a power to each temp

intCp=intCOEFF\*intTEMP';%Calculate integral values for 4 polynomial functions

intCp(1)=5/2\*R(1)\*temp;%Assign integrated values of constant 5/2\*R values = 5/2\*R\*temp

intCp(2)=5/2\*R(2)\*temp;

intCv=intCvCOEFF\*intTEMP';

intCv(1)=3/2\*R(1)\*temp;

intCv(2)=3/2\*R(2)\*temp;

CpMIXA=X\*Cp;%multiply matrices to calculate values

intCpMIXA(i)=X\*intCp;

intCvMIXA(i)=X\*intCv;

CvMIXA=CpMIXA-RMIX;

sMIX(i)=X\*s;

i=i+1;

end

h=intCpMIXA(1)-intCpMIXA(2)+hrefMIX;

u=intCvMIXA(1)-intCvMIXA(2)+urefMIX;

S=sMIX(1)-sMIX(2)+srefMIX;%-RMIX\*log(pressKPA/Pref);

%Calculate other values

CpMIX=X\*Cp;

CvMIX=RMIX-CpMIX;

K=CpMIX/CvMIX;

y=[h u S K];