

Turbojet analysis

Homework 5, Problem 1

```
clear, clc, format compact
global R cpc cph gc gh
global etad etac etab etat etamech etaAB etan

% Gas properties...
R = 1716; % ft-lb/slug/R
cpc = 6004; % ft-lb/slug/R
cph = 6578; % ft-lb/slug/R
gc = 1.4;
gh = 1.352;

% Define component efficiencies...
etad = 0.92;
etac = 0.85;
etab = 0.98;
etat = 0.89;
etamech = 1;
etaAB = 1;
etan = 0.95;

% Define component pressure ratios...
pid = 1;
pic = 12;
plb = 0.97;
pin = 1;

% Other inputs...
MO = 0.8;
h = 27000; % ft
mdot = 100; % lbm/sec
TT4 = 1300*1.8; % deg R
Hf = 18500; % BTU/lbm

% Unit conversions...
mdot = mdot/32.2; % slug/sec
Hf = Hf*778.2*32.2; % ft-lb/slug

[Tnet Tspec TSFC etap etath etao]=turbojet(MO, h, mdot, TT4, pid, pic, plb, pin, Hf)
```

```
f =
    0.0205
PRcrit =
    0.5365
PRexit =
    0.1714
M7 =
    1.0000
V7 =
    1.8433e+003
A7 =
    2.0239
Tnet =
    6.4407e+003
Tspec =
    2.0739e+003
TSFC =
    1.1448
etap =
    0.4470
etath =
    0.3938
etao =
    0.1760
```

Turbojet analysis

Homework 5, Problem 2

```
clear, clc, format compact
global R cpc cph gc gh
global etad etac etab etat etamech etaAB etan

% Gas properties...
R = 1716;          % ft-lb/slug/R
cpc = 6014;       % ft-lb/slug/R
cph = 6014;       % ft-lb/slug/R
gc = 1.4;
gh = 1.4;

% Define component efficiencies...
etad = 1;
etac = 0.88;
etab = 0.95;
etat = 0.92;
etamech = 1;
etaAB = 1;
etan = 1;

% Define component pressure ratios...
pid = 1;
pic = 19;
plb = 0.94;
pin = 0.96;

% Other inputs...
MO = 0.85;
h = 33200;        % ft
mdot = 100;       % lbm/sec
TT4 = 2600;      % deg R
Hf = 18500;      % BTU/lbm

% Unit conversions...
mdot = mdot/32.2; % slug/sec
Hf = Hf*778.2*32.2; % ft-lb/slug

[Tnet Tspec TSFC etap etath etao]=turbojet(MO, h, mdot, TT4, pid, pic, plb, pin, Hf)

f =
    0.0206
PRcrit =
    0.5283
PRexit =
    0.1156
M7 =
    1
V7 =
    1.9655e+003
A7 =
    1.7933
Tnet =
    7.1126e+003
Tspec =
    2.2903e+003
TSFC =
    1.0427
etap =
    0.4306
etath =
    0.4642
etao =
    0.1999
```

Turbojet analysis

Homework 5, Problem 2a

```

clear, clc, format compact
global R cpc cph gc gh
global etad etac etab etat etamech etaAB etan

% Gas properties...
R = 1716;          % ft-lb/slug/R
cpc = 6014;       % ft-lb/slug/R
cph = 6014;       % ft-lb/slug/R
gc = 1.4;
gh = 1.4;

% Define component efficiencies...
etad = 1;
etac = 0.88;
etab = 0.95;
etat = 0.92;
etamech = 1;
etaAB = 1;
etan = 1;

% Define component pressure ratios...
pid = 1;
pic = [1:0.5:2 2.167 3:10]
pib = 0.94;
pin = 0.96;

% Other inputs...
MO = 0.85;
h = 33200;        % ft
mdot = 100;       % lbm/sec
TT4 = 3200;       % deg R
Hf = 18500;       % BTU/lbm

% Unit conversions...
mdot = mdot/32.2; % slug/sec
Hf = Hf*778.2*32.2; % ft-lb/slug

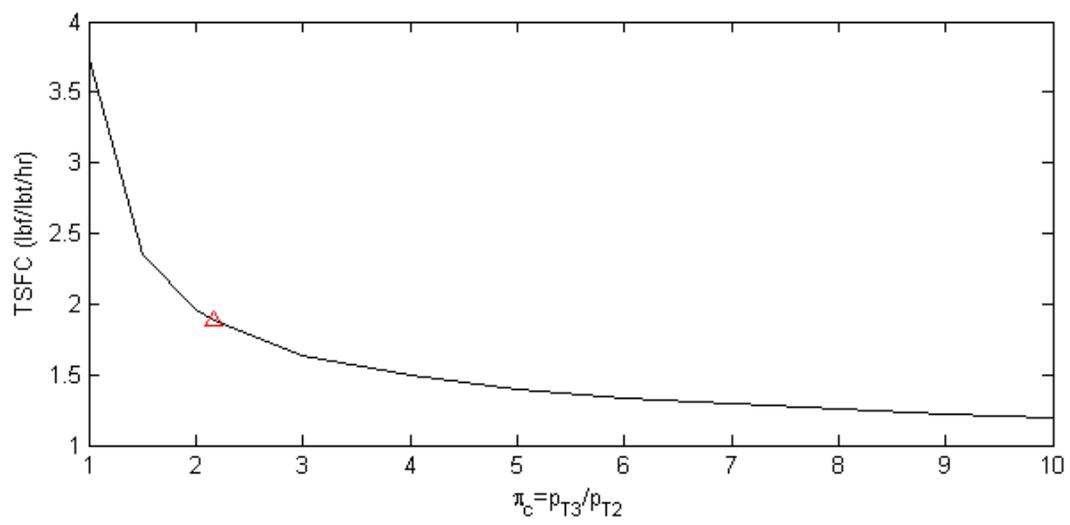
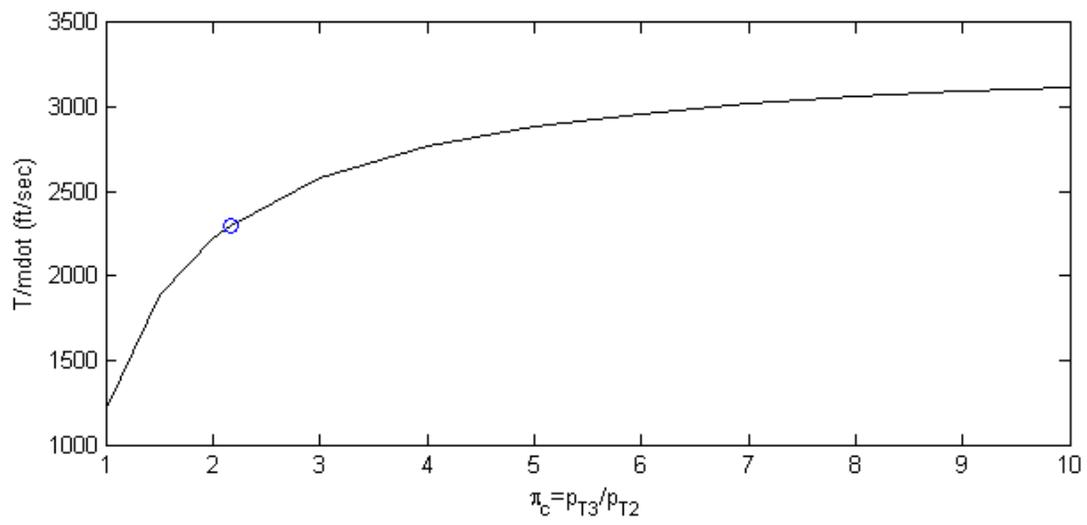
[Tnet Tspec TSFC etap etath etao]=turbojet(MO, h, mdot, TT4, pid, pic, pib, pin, Hf)

figure
set(gcf, 'color', 'white', 'position', [200 200 700 700])
subplot(2,1,1)
plot(pic, Tspec, '-k', pic(4), Tspec(4), 'ob')
xlabel('\pi_c=p_{T3}/p_{T2}')
ylabel('T/mdot (ft/sec)')
subplot(2,1,2)
plot(pic, TSFC, '-k', pic(4), TSFC(4), '^r')
xlabel('\pi_c=p_{T3}/p_{T2}')
ylabel('TSFC (lb/hr)')

pic =
Columns 1 through 9
1.0000 1.5000 2.0000 2.1670 3.0000 4.0000 5.0000 6.0000 7.0000
Columns 10 through 12
8.0000 9.0000 10.0000
TT4 =
3200
f =
Columns 1 through 9
0.0392 0.0382 0.0375 0.0373 0.0364 0.0355 0.0348 0.0342 0.0336
Columns 10 through 12
0.0331 0.0327 0.0322
PRcrit =
0.5283
PRexit =
Columns 1 through 9
0.6909 0.4960 0.3947 0.3707 0.2891 0.2339 0.1996 0.1761 0.1589
Columns 10 through 12
0.1458 0.1354 0.1269
M7 =
Columns 1 through 9
0.7463 1.0531 1.2334 1.2802 1.4586 1.6039 1.7097 1.7922 1.8592
Columns 10 through 12

```

	1. 9152	1. 9631	2. 0046						
V7 =	1. 0e+003 *								
	Columns 1 through 9								
	1. 9642	2. 6178	2. 9445	3. 0221	3. 2900	3. 4752	3. 5913	3. 6704	3. 7271
	Columns 10 through 12								
	3. 7692	3. 8010	3. 8255						
A7 =	Columns 1 through 9								
	13. 8677	10. 1961	8. 9191	8. 6483	7. 7796	7. 2146	6. 8599	6. 6091	6. 4186
	Columns 10 through 12								
	6. 2668	6. 1416	6. 0355						
Tnet =	1. 0e+003 *								
	Columns 1 through 9								
	3. 7502	5. 8521	6. 8990	7. 1471	8. 0008	8. 5874	8. 9526	9. 1997	9. 3754
	Columns 10 through 12								
	9. 5045	9. 6012	9. 6746						
Tspec =	1. 0e+003 *								
	Columns 1 through 9								
	1. 2076	1. 8844	2. 2215	2. 3014	2. 5762	2. 7651	2. 8827	2. 9623	3. 0189
	Columns 10 through 12								
	3. 0604	3. 0916	3. 1152						
TSFC =	Columns 1 through 9								
	3. 7585	2. 3524	1. 9581	1. 8796	1. 6384	1. 4899	1. 3999	1. 3377	1. 2912
	Columns 10 through 12								
	1. 2545	1. 2246	1. 1995						
etap =	Columns 1 through 9								
	0. 6074	0. 4893	0. 4462	0. 4370	0. 4081	0. 3903	0. 3799	0. 3731	0. 3683
	Columns 10 through 12								
	0. 3649	0. 3623	0. 3604						
etath =	Columns 1 through 9								
	0. 0913	0. 1811	0. 2386	0. 2538	0. 3117	0. 3584	0. 3920	0. 4177	0. 4383
	Columns 10 through 12								
	0. 4553	0. 4698	0. 4822						
etao =	Columns 1 through 9								
	0. 0555	0. 0886	0. 1064	0. 1109	0. 1272	0. 1399	0. 1489	0. 1558	0. 1614
	Columns 10 through 12								
	0. 1661	0. 1702	0. 1738						



Turbojet analysis

Homework 5, Problem 2b

```
clear, clc, format compact
global R cpc cph gc gh
global etad etac etab etat etamech etaAB etan
```

```
% Gas properties...
R = 1716; % ft-lb/slug/R
cpc = 6014; % ft-lb/slug/R
cph = 6014; % ft-lb/slug/R
gc = 1.4;
gh = 1.4;
```

```
% Define component efficiencies...
etad = 1;
etac = 0.88;
etab = 0.95;
etat = 0.92;
etamech = 1;
etaAB = 1;
etan = 1;
```

```
% Define component pressure ratios...
pid = 1;
pic = 19;
pib = 0.94;
pin = 0.96;
```

```
% Other inputs...
MO = 0.85;
h = 33200; % ft
mdot = 100; % lbm/sec
TT4 = [1800:200:3200] % deg R
Hf = 18500; % BTU/lbm
```

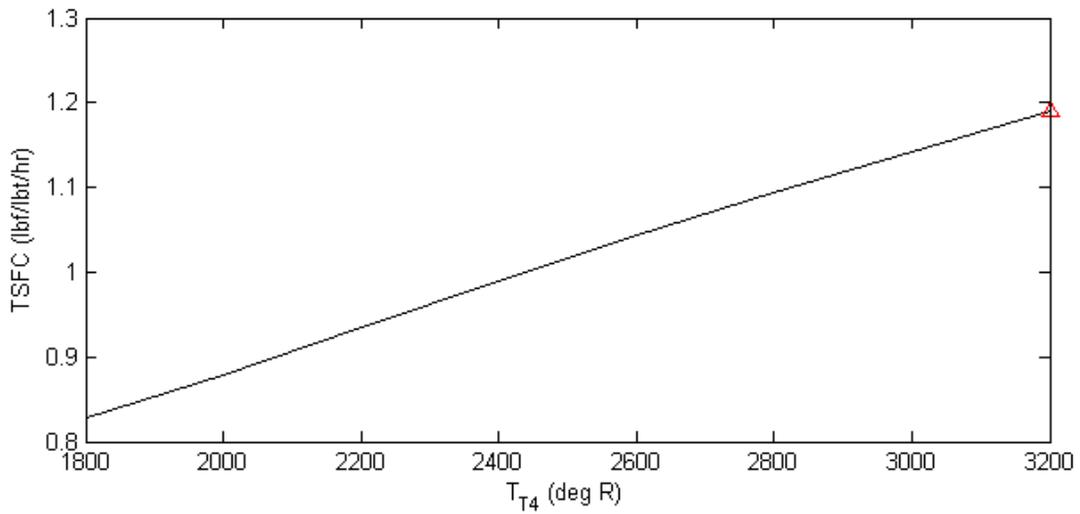
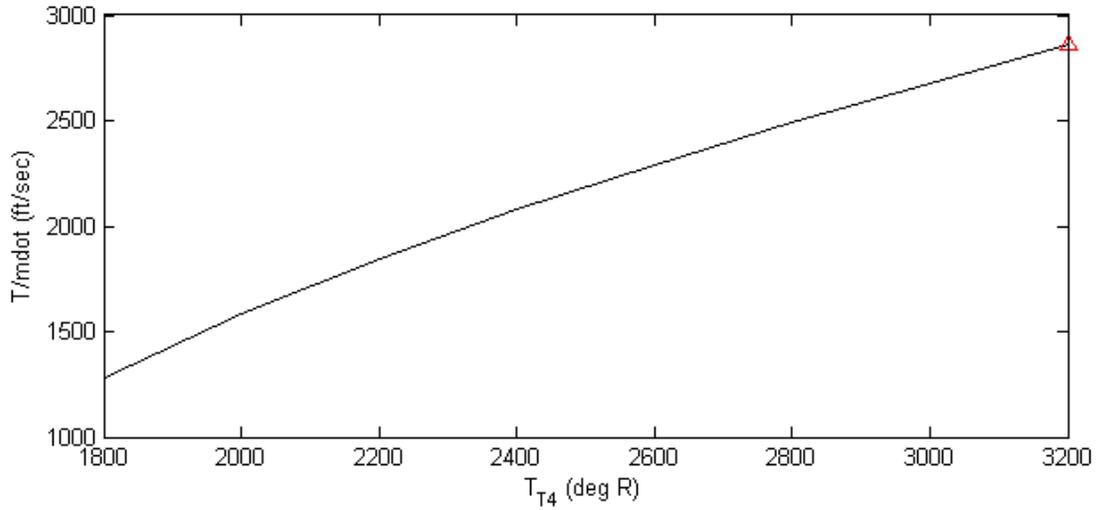
```
% Unit conversions...
mdot = mdot/32.2; % slug/sec
Hf = Hf*778.2*32.2; % ft-lb/slug
```

```
[Tnet Tspec TSFC etap etath etao]=turbojet(MO, h, mdot, TT4, pid, pic, pib, pin, Hf)
```

```
figure
set(gcf, 'color', 'white', 'position', [200 200 700 700])
subplot(2,1,1)
plot(TT4, Tspec, '-k', TT4(end), Tspec(end), '^r')
xlabel('T_{T4} (deg R)')
ylabel('T/mdot (ft/sec)')
subplot(2,1,2)
plot(TT4, TSFC, '-k', TT4(end), TSFC(end), '^r')
xlabel('T_{T4} (deg R)')
ylabel('TSFC (lbf/lb/hr)')
```

```
pic =
    19
TT4 =
Columns 1 through 7
    1800    2000    2200    2400    2600    2800    3000
Column 8
    3200
f =
    0.0092    0.0120    0.0149    0.0177    0.0206    0.0235    0.0264    0.0293
PRcrit =
    0.5283
PRexit =
    0.2319    0.1821    0.1511    0.1304    0.1156    0.1046    0.0961    0.0894
M7 =
    1    1    1    1    1    1    1    1
V7 =
    1.0e+003 *
    1.4980    1.6275    1.7474    1.8596    1.9655    2.0659    2.1616    2.2533
A7 =
    2.7114    2.3196    2.0733    1.9085    1.7933    1.7103    1.6493    1.6040
Tnet =
    1.0e+003 *
    3.9852    4.9176    5.7234    6.4470    7.1126    7.7347    8.3227    8.8831
```

Tspec =
 1.0e+003 *
 1.2832 1.5835 1.8429 2.0759 2.2903 2.4906 2.6799 2.8604
TSFC =
 0.8284 0.8788 0.9343 0.9894 1.0427 1.0937 1.1426 1.1893
etap =
 0.5712 0.5199 0.4828 0.4540 0.4306 0.4110 0.3943 0.3796
etath =
 0.4405 0.4563 0.4621 0.4640 0.4642 0.4636 0.4627 0.4617
etao =
 0.2516 0.2372 0.2231 0.2107 0.1999 0.1906 0.1824 0.1753



Turbojet analysis

Homework 5, Problem 3a

```

clear, clc, format compact
global R cpc cph gc gh
global etad etac etab etat etamech etaAB etan

% Gas properties...
R = 1716;          % ft-lb/slug/R
cpc = 6010;       % ft-lb/slug/R
cph = 6010;       % ft-lb/slug/R
gc = 1.4;
gh = 1.4;

% Define component efficiencies...
etad = 1;
etac = 1;
etab = 1;
etat = 1;
etamech = 1;
etaAB = 1;
etan = 1;

% Define component pressure ratios...
pid = 1;
pic = [2:6 8:2:10 15:5:20];
pib = 1;
pin = 1;

% Other inputs...
MO = 0.85;
h = 33200;        % ft
mdot = 100;       % lbm/sec
TT4array = [1800 1400 1000]*1.8 % deg R
Hf = 18500;       % BTU/lbm

% Unit conversions...
mdot = mdot/32.2; % slug/sec
Hf = Hf*778.2*32.2; % ft-lb/slug

for k=1:length(TT4array)
    TT4 = TT4array(k)
    [Tnet Tspec TSFC etap etath etao]=turbojet(MO, h, mdot, TT4, pid, pic, pib, pin, Hf)
    Tspecdata(k,:) = Tspec(:);
    TSFCdata(k,:) = TSFC(:);
end

figure
set(gcf, 'color', 'white', 'position', [200 200 700 700])
subplot(2,1,1)
plot(pic, Tspecdata(1,:), ':k', pic, Tspecdata(2,:), '-b', pic, Tspecdata(3,:), '--r')
% legend('TT4=1800 K', 'TT4=1400 K', 'TT4=1000 K', 'best')
xlabel('\pi_c=p_{T3}/p_{T2}')
ylabel('T/mdot (ft/sec)')
subplot(2,1,2)
plot(pic, TSFCdata(1,:), ':k', pic, TSFCdata(2,:), '-b', pic, TSFCdata(3,:), '--r')
legend('T_{T4}=1800 K', 'T_{T4}=1400 K', 'T_{T4}=1000 K', 'best')
xlabel('\pi_c=p_{T3}/p_{T2}')
ylabel('TSFC (lbm/hr)')

```

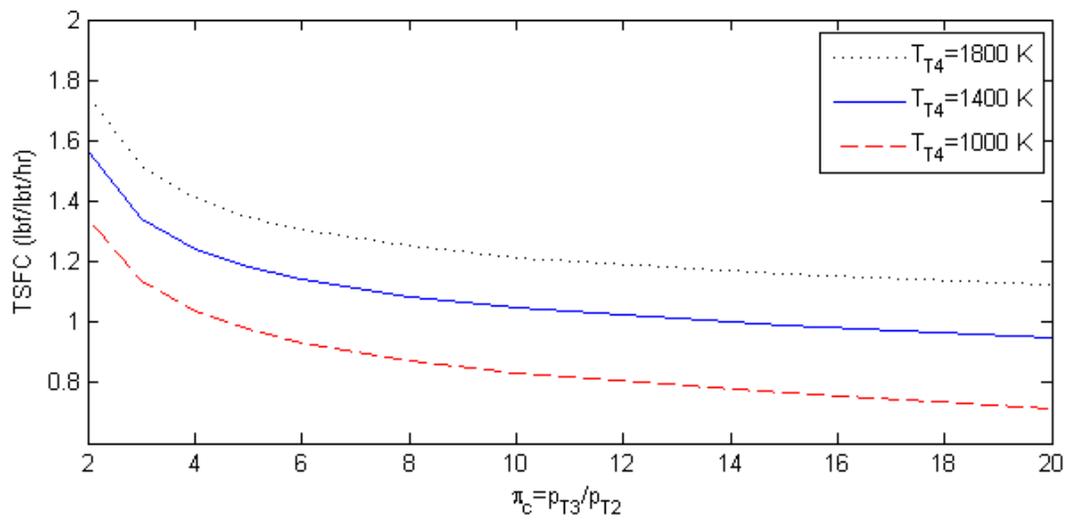
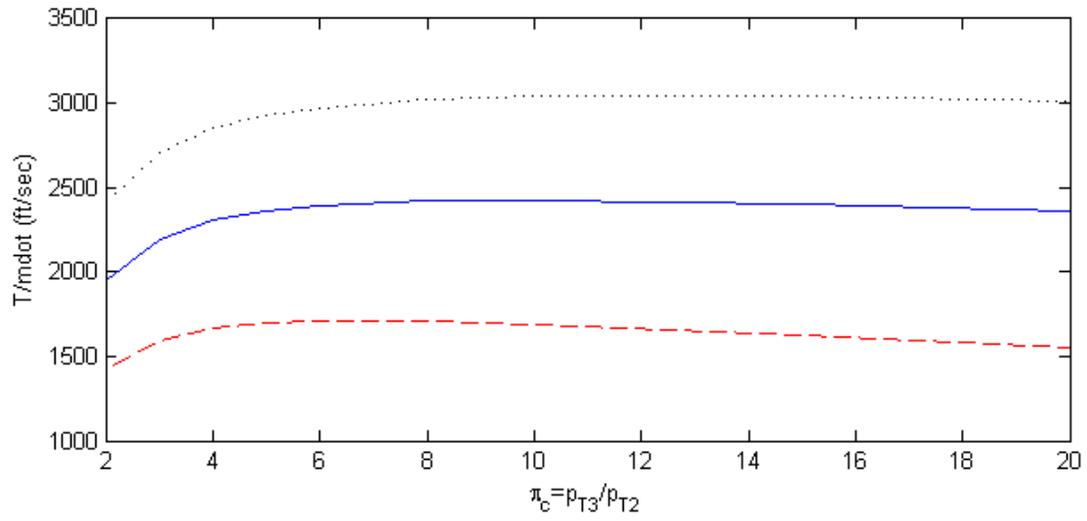
```

pic =
    2     3     4     5     6     8    10    15    20
TT4array =
    3240          2520          1800
TT4 =
    3240
f =
    0.0363    0.0354    0.0346    0.0340    0.0335    0.0326    0.0319    0.0304    0.0293
PRcrit =
    0.5283
PRexit =
    0.3467    0.2490    0.1983    0.1669    0.1454    0.1177    0.1005    0.0766    0.0641
M7 =
    1     1     1     1     1     1     1     1     1
V7 =
    1.0e+003 *

```

2. 5093	2. 4827	2. 4616	2. 4439	2. 4284	2. 4020	2. 3797	2. 3347	2. 2987	
A7 =	6. 9778	4. 9549	3. 9085	3. 2637	2. 8240	2. 2597	1. 9104	1. 4263	1. 1730
Tnet =	1. 0e+003 *								
7. 4688	8. 4064	8. 8480	9. 0919	9. 2382	9. 3876	9. 4451	9. 4418	9. 3677	
Tspec =	1. 0e+003 *								
2. 4049	2. 7069	2. 8490	2. 9276	2. 9747	3. 0228	3. 0413	3. 0403	3. 0164	
TSFC =	1. 7492	1. 5143	1. 4092	1. 3473	1. 3055	1. 2508	1. 2150	1. 1593	1. 1243
etap =	0. 4254	0. 3954	0. 3826	0. 3758	0. 3718	0. 3676	0. 3659	0. 3655	0. 3669
etath =	0. 2802	0. 3481	0. 3866	0. 4116	0. 4294	0. 4533	0. 4688	0. 4920	0. 5053
etao =	0. 1192	0. 1376	0. 1479	0. 1547	0. 1597	0. 1666	0. 1716	0. 1798	0. 1854
TT4 =	2520								
f =	0. 0263	0. 0254	0. 0246	0. 0240	0. 0235	0. 0227	0. 0219	0. 0205	0. 0193
PRcrit =	0. 5283								
PRexit =	0. 3581	0. 2633	0. 2137	0. 1829	0. 1617	0. 1344	0. 1175	0. 0940	0. 0820
M7 =	1	1	1	1	1	1	1	1	1
V7 =	1. 0e+003 *								
2. 2028	2. 1722	2. 1478	2. 1272	2. 1093	2. 0785	2. 0524	1. 9995	1. 9570	
A7 =	6. 2656	4. 5396	3. 6406	3. 0837	2. 7027	2. 2119	1. 9073	1. 4852	1. 2660
Tnet =	1. 0e+003 *								
6. 0471	6. 8047	7. 1509	7. 3338	7. 4365	7. 5253	7. 5407	7. 4661	7. 3419	
Tspec =	1. 0e+003 *								
1. 9472	2. 1911	2. 3026	2. 3615	2. 3945	2. 4232	2. 4281	2. 4041	2. 3641	
TSFC =	1. 5651	1. 3422	1. 2410	1. 1805	1. 1390	1. 0836	1. 0464	0. 9867	0. 9475
etap =	0. 4746	0. 4440	0. 4311	0. 4245	0. 4208	0. 4175	0. 4166	0. 4185	0. 4221
etath =	0. 2806	0. 3498	0. 3896	0. 4159	0. 4348	0. 4608	0. 4781	0. 5048	0. 5211
etao =	0. 1332	0. 1553	0. 1680	0. 1766	0. 1830	0. 1924	0. 1992	0. 2112	0. 2200
TT4 =	1800								
f =	0. 0165	0. 0156	0. 0149	0. 0143	0. 0137	0. 0129	0. 0122	0. 0107	0. 0096
PRcrit =	0. 5283								
PRexit =	0. 3798	0. 2918	0. 2457	0. 2171	0. 1977	0. 1731	0. 1585	0. 1406	0. 1344
M7 =	1	1	1	1	1	1	1	1	1
V7 =	1. 0e+003 *								
1. 8461	1. 8091	1. 7795	1. 7543	1. 7323	1. 6943	1. 6619	1. 5955	1. 5413	
A7 =	5. 5164	4. 1498	3. 4339	2. 9901	2. 6870	2. 2997	2. 0641	1. 7554	1. 6182
Tnet =	1. 0e+003 *								
4. 4085	4. 9401	5. 1613	5. 2607	5. 3012	5. 2985	5. 2453	5. 0423	4. 8159	
Tspec =	1. 0e+003 *								
1. 4195	1. 5907	1. 6620	1. 6940	1. 7070	1. 7061	1. 6890	1. 6236	1. 5507	
TSFC =	1. 3458	1. 1346	1. 0362	0. 9760	0. 9335	0. 8749	0. 8340	0. 7647	0. 7162
etap =	0. 5504	0. 5208	0. 5092	0. 5040	0. 5017	0. 5014	0. 5035	0. 5127	0. 5237
etath =	0. 2814	0. 3527	0. 3950	0. 4238	0. 4450	0. 4752	0. 4963	0. 5316	0. 5557
etao =	0. 1549	0. 1837	0. 2011	0. 2136	0. 2233	0. 2382	0. 2499	0. 2726	0. 2910

Warning: Ignoring extra legend entries.



Turbojet analysis

Homework 5, Problem 3b

```

clear, clc, format compact
global R cpc cph gc gh
global etad etac etab etat etamech etaAB etan

% Gas properties...
R = 1716; % ft-lb/slug/R
cpc = 6010; % ft-lb/slug/R
cph = 6010; % ft-lb/slug/R
gc = 1.4;
gh = 1.4;

% Define component efficiencies...
etad = 1;
etac = 1;
etab = 1;
etat = 1;
etamech = 1;
etaAB = 1;
etan = 1;

% Define component pressure ratios...
pid = 1;
pic = [2:6 8:2:10 15:5:20];
pi b = 1;
pin = 1;

% Other inputs...
M0array = [0.4 0.8 1.2];
h = 33200; % ft
mdot = 100; % lbm/sec
TT4 = 1400*1.8 % deg R
Hf = 18500; % BTU/lbm

% Unit conversions...
mdot = mdot/32.2; % slug/sec
Hf = Hf*778.2*32.2; % ft-lb/slug

for k=1:length(M0array)
    MO = M0array(k)
    [Tnet Tspec TSFC etap etath etao]=turbojet(MO, h, mdot, TT4, pid, pic, pi b, pin, Hf)
    Tspecdata(k,:) = Tspec(:);
    TSFCdata(k,:) = TSFC(:);
end

figure
set(gcf, 'color', 'white', 'position', [200 200 700 700])
subplot(2,1,1)
plot(pic, Tspecdata(1,:), ':k', pic, Tspecdata(2,:), '-b', pic, Tspecdata(3,:), '--r')
% legend('TT4=1000 K', 'TT4=1400 K', 'TT4=1800 K', 'best')
xlabel('\pi_c=p_{T3}/p_{T2}')
ylabel('T/mdot (ft/sec)')
subplot(2,1,2)
plot(pic, TSFCdata(1,:), ':k', pic, TSFCdata(2,:), '-b', pic, TSFCdata(3,:), '--r')
legend('M_0=0.4', 'M_0=0.8', 'M_0=1.2', 'best')
xlabel('\pi_c=p_{T3}/p_{T2}')
ylabel('TSFC (lbm/lbf/hr)')

```

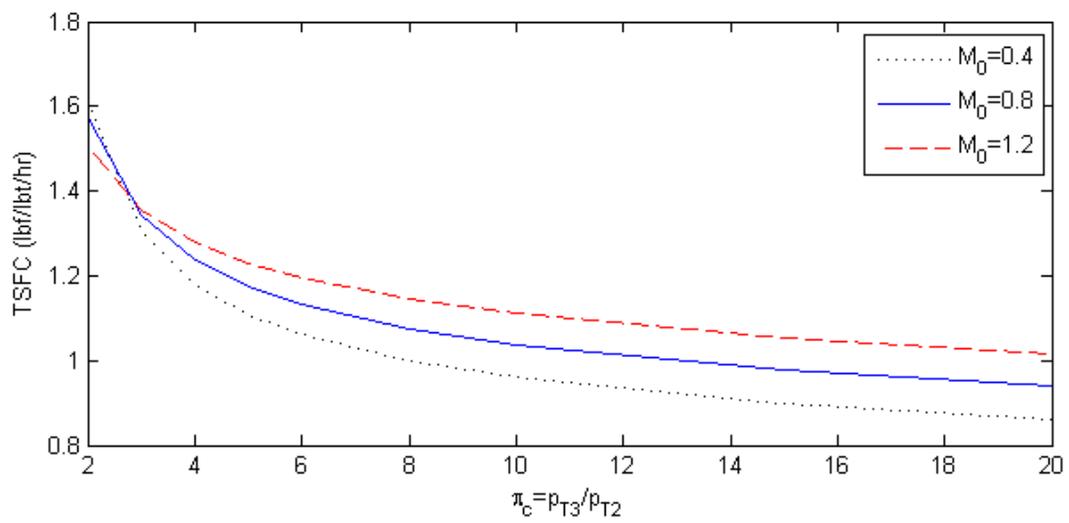
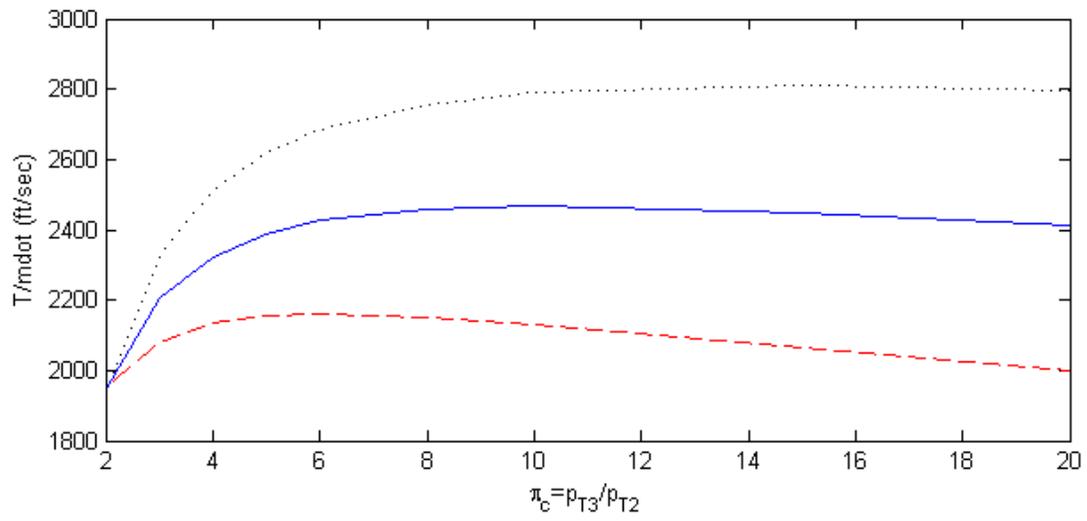
```

pic =
    2     3     4     5     6     8    10    15    20
TT4 =
    2520
M0 =
    0.4000
f =
    0.0270    0.0262    0.0255    0.0250    0.0245    0.0237    0.0231    0.0218    0.0207
PRcrit =
    0.5283
PRexit =
    0.5072    0.3692    0.2972    0.2524    0.2218    0.1822    0.1576    0.1234    0.1056
M7 =
    1     1     1     1     1     1     1     1     1
V7 =

```

1.0e+003 *									
A7 =	2.2072	2.1797	2.1578	2.1394	2.1233	2.0958	2.0726	2.0255	1.9877
Tnet =	8.8993	6.3922	5.0898	4.2846	3.7343	3.0261	2.5868	1.9770	1.6583
1.0e+003 *									
Tspec =	6.0224	7.2213	7.8006	8.1304	8.3356	8.5608	8.6651	8.7250	8.6816
1.0e+003 *									
TSFC =	1.9392	2.3253	2.5118	2.6180	2.6841	2.7566	2.7902	2.8094	2.7955
etap =	1.6155	1.3059	1.1790	1.1072	1.0597	0.9985	0.9591	0.8983	0.8602
etath =	0.2960	0.2590	0.2442	0.2364	0.2318	0.2269	0.2246	0.2231	0.2238
etao =	0.2051	0.2900	0.3407	0.3747	0.3993	0.4329	0.4553	0.4894	0.5096
MO =	0.0607	0.0751	0.0832	0.0886	0.0926	0.0982	0.1023	0.1092	0.1140
f =	0.8000								
PRcrit =	0.0264	0.0255	0.0248	0.0242	0.0237	0.0228	0.0221	0.0207	0.0195
PRexit =	0.5283								
M7 =	0.3760	0.2761	0.2238	0.1913	0.1690	0.1402	0.1224	0.0976	0.0849
V7 =	1	1	1	1	1	1	1	1	1
1.0e+003 *									
A7 =	2.2035	2.1733	2.1493	2.1290	2.1113	2.0810	2.0554	2.0033	1.9615
Tnet =	6.5814	4.7623	3.8151	3.2287	2.8274	2.3105	1.9897	1.5451	1.3138
1.0e+003 *									
Tspec =	6.0330	6.8436	7.2181	7.4188	7.5341	7.6398	7.6662	7.6088	7.4951
1.0e+003 *									
TSFC =	1.9426	2.2037	2.3242	2.3889	2.4260	2.4600	2.4685	2.4500	2.4134
etap =	1.5752	1.3409	1.2360	1.1738	1.1313	1.0749	1.0373	0.9773	0.9381
etath =	0.4597	0.4273	0.4137	0.4067	0.4027	0.3989	0.3977	0.3990	0.4022
etao =	0.2709	0.3424	0.3837	0.4110	0.4306	0.4575	0.4755	0.5031	0.5199
MO =	0.1245	0.1463	0.1587	0.1671	0.1734	0.1825	0.1891	0.2007	0.2091
f =	1.2000								
PRcrit =	0.0254	0.0243	0.0235	0.0228	0.0222	0.0213	0.0204	0.0188	0.0175
PRexit =	0.5283								
M7 =	0.2411	0.1797	0.1474	0.1274	0.1136	0.0959	0.0850	0.0701	0.0627
V7 =	1	1	1	1	1	1	1	1	1
1.0e+003 *									
A7 =	2.1972	2.1625	2.1349	2.1116	2.0912	2.0561	2.0264	1.9658	1.9169
Tnet =	4.2041	3.0804	2.4934	2.1293	1.8800	1.5588	1.3599	1.0860	0.9463
1.0e+003 *									
Tspec =	6.0571	6.4652	6.6237	6.6863	6.7037	6.6765	6.6139	6.4161	6.2134
1.0e+003 *									
TSFC =	1.9504	2.0818	2.1328	2.1530	2.1586	2.1498	2.1297	2.0660	2.0007
etap =	1.5067	1.3540	1.2775	1.2292	1.1946	1.1462	1.1122	1.0545	1.0146
etath =	0.5631	0.5455	0.5388	0.5359	0.5349	0.5354	0.5373	0.5441	0.5515
etao =	0.3469	0.3984	0.4275	0.4467	0.4605	0.4796	0.4924	0.5129	0.5259
MO =	0.1953	0.2173	0.2303	0.2394	0.2463	0.2567	0.2646	0.2790	0.2900

Warning: Ignoring extra legend entries.



Turbojet analysis

Homework 5, Problem 3c

```

clear, clc, format compact
global R cpc cph gc gh
global etad etac etab etat etamech etaAB etan

% Gas properties...
R = 1716; % ft-lb/slug/R
cpc = 6010; % ft-lb/slug/R
cph = 6010; % ft-lb/slug/R
gc = 1.4;
gh = 1.4;

% Define component efficiencies...
etad = 1;
etac = 1;
etab = 1;
etat = 1;
etamech = 1;
etaAB = 1;
etan = 1;

% Define component pressure ratios...
pid = 1;
pic = [2:6 8:2:10 15:5:20];
pi b = 1;
pin = 1;

% Other inputs...
MO = 0.85;
harray = [0 10000 20000]; % ft
mdot = 100; % lbm/sec
TT4 = 1400*1.8 % deg R
Hf = 18500; % BTU/lbm

% Unit conversions...
mdot = mdot/32.2; % slug/sec
Hf = Hf*778.2*32.2; % ft-lb/slug

for k=1:length(harray)
    h = harray(k)
    [Tnet Tspec TSFC etap etath etao]=turbojet(MO, h, mdot, TT4, pid, pic, pi b, pin, Hf)
    Tspecdata(k,:) = Tspec(:);
    TSFCdata(k,:) = TSFC(:);
end

figure
set(gcf, 'color', 'white', 'position', [200 200 700 700])
subplot(2,1,1)
plot(pic, Tspecdata(1,:), ':k', pic, Tspecdata(2,:), '-b', pic, Tspecdata(3,:), '--r')
% legend('TT4=1000 K', 'TT4=1400 K', 'TT4=1800 K', 'best')
xlabel('\pi_c=p_{T3}/p_{T2}')
ylabel('T/mdot (ft/sec)')
subplot(2,1,2)
plot(pic, TSFCdata(1,:), ':k', pic, TSFCdata(2,:), '-b', pic, TSFCdata(3,:), '--r')
legend('h=sea level', 'h=10,000 ft', 'h=20,000 ft')
xlabel('\pi_c=p_{T3}/p_{T2}')
ylabel('TSFC (lbm/lbf/hr)')

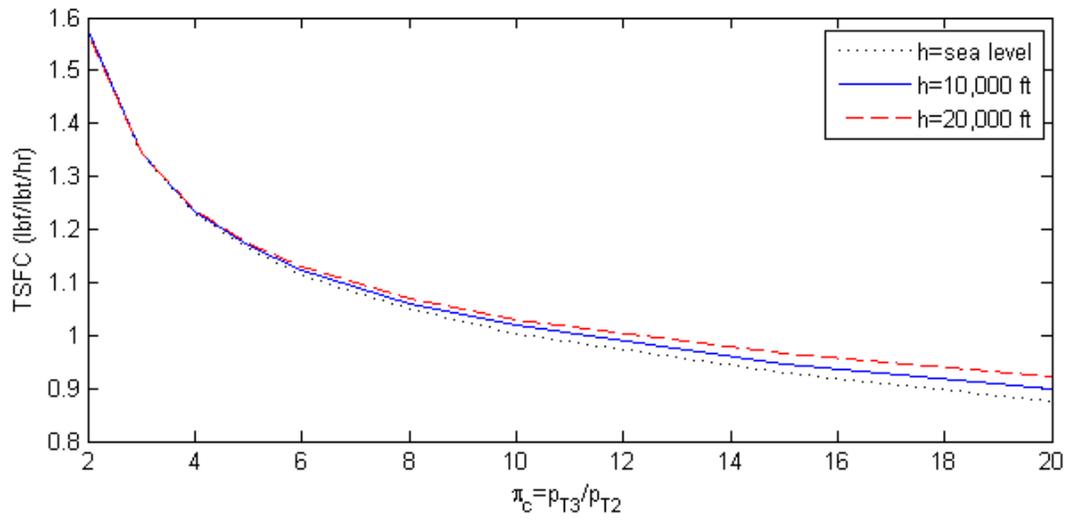
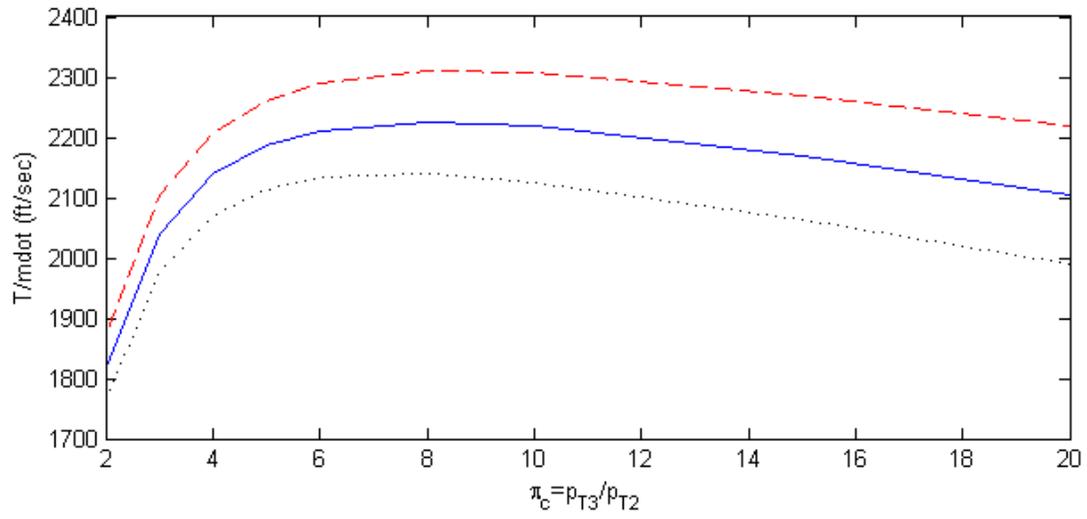
```

```

pic =
    2     3     4     5     6     8    10    15    20
TT4 =
    2520
h =
    0
f =
    0.0241    0.0229    0.0220    0.0212    0.0205    0.0194    0.0184    0.0165    0.0150
PRcrit =
    0.5283
PRexit =
    0.3736    0.2835    0.2363    0.2069    0.1868    0.1612    0.1457    0.1254    0.1167
M7 =
    1     1     1     1     1     1     1     1     1
V7 =

```

1. 0e+003 *									
2. 1895	2. 1493	2. 1173	2. 0901	2. 0662	2. 0253	1. 9904	1. 9189	1. 8608	
A7 =									
1. 6610	1. 2361	1. 0137	0. 8756	0. 7812	0. 6600	0. 5855	0. 4852	0. 4370	
Tnet =									
1. 0e+003 *									
5. 4723	6. 1389	6. 4245	6. 5601	6. 6228	6. 6446	6. 6029	6. 4083	6. 1814	
Tspec =									
1. 0e+003 *									
1. 7621	1. 9767	2. 0687	2. 1123	2. 1326	2. 1396	2. 1261	2. 0635	1. 9904	
TSFC =									
1. 5838	1. 3420	1. 2300	1. 1619	1. 1143	1. 0490	1. 0039	0. 9284	0. 8764	
etap =									
0. 5328	0. 5024	0. 4901	0. 4843	0. 4815	0. 4801	0. 4812	0. 4879	0. 4963	
etath =									
0. 2812	0. 3519	0. 3936	0. 4216	0. 4422	0. 4711	0. 4911	0. 5238	0. 5455	
etao =									
0. 1498	0. 1768	0. 1929	0. 2042	0. 2129	0. 2262	0. 2363	0. 2556	0. 2707	
h =									
10000									
f =									
0. 0247	0. 0236	0. 0228	0. 0220	0. 0214	0. 0204	0. 0195	0. 0177	0. 0163	
PRcrit =									
0. 5283									
PRexit =									
0. 3688	0. 2772	0. 2291	0. 1992	0. 1788	0. 1525	0. 1363	0. 1147	0. 1045	
M7 =									
1 1 1 1 1 1 1 1									
V7 =									
1. 0e+003 *									
2. 1936	2. 1563	2. 1265	2. 1014	2. 0793	2. 0415	2. 0093	1. 9436	1. 8904	
A7 =									
2. 3904	1. 7644	1. 4370	1. 2338	1. 0947	0. 9157	0. 8051	0. 6542	0. 5788	
Tnet =									
1. 0e+003 *									
5. 6414	6. 3363	6. 6409	6. 7915	6. 8671	6. 9104	6. 8872	6. 7321	6. 5396	
Tspec =									
1. 0e+003 *									
1. 8165	2. 0403	2. 1384	2. 1869	2. 2112	2. 2251	2. 2177	2. 1677	2. 1058	
TSFC =									
1. 5789	1. 3427	1. 2340	1. 1682	1. 1225	1. 0603	1. 0177	0. 9472	0. 8993	
etap =									
0. 5161	0. 4854	0. 4729	0. 4668	0. 4636	0. 4615	0. 4619	0. 4668	0. 4735	
etath =									
0. 2810	0. 3513	0. 3924	0. 4199	0. 4399	0. 4679	0. 4871	0. 5178	0. 5377	
etao =									
0. 1450	0. 1705	0. 1855	0. 1960	0. 2040	0. 2159	0. 2250	0. 2417	0. 2546	
h =									
20000									
f =									
0. 0254	0. 0244	0. 0236	0. 0229	0. 0223	0. 0213	0. 0205	0. 0189	0. 0176	
PRcrit =									
0. 5283									
PRexit =									
0. 3641	0. 2711	0. 2223	0. 1920	0. 1712	0. 1443	0. 1277	0. 1051	0. 0939	
M7 =									
1 1 1 1 1 1 1 1									
V7 =									
1. 0e+003 *									
2. 1976	2. 1631	2. 1357	2. 1126	2. 0923	2. 0575	2. 0280	1. 9679	1. 9194	
A7 =									
3. 5404	2. 5923	2. 0971	1. 7899	1. 5796	1. 3087	1. 1408	0. 9096	0. 7914	
Tnet =									
1. 0e+003 *									
5. 8138	6. 5361	6. 8591	7. 0241	7. 1117	7. 1754	7. 1695	7. 0508	6. 8895	
Tspec =									
1. 0e+003 *									
1. 8720	2. 1046	2. 2086	2. 2618	2. 2900	2. 3105	2. 3086	2. 2704	2. 2184	
TSFC =									
1. 5734	1. 3429	1. 2374	1. 1740	1. 1301	1. 0708	1. 0306	0. 9649	0. 9209	
etap =									
0. 4987	0. 4679	0. 4552	0. 4489	0. 4454	0. 4427	0. 4426	0. 4460	0. 4512	
etath =									
0. 2808	0. 3506	0. 3912	0. 4182	0. 4377	0. 4648	0. 4831	0. 5120	0. 5303	
etao =									
0. 1400	0. 1641	0. 1781	0. 1877	0. 1950	0. 2058	0. 2138	0. 2284	0. 2393	



Turbojet analysis

Homework 5, Problem 3d

```

clear, clc, format compact
global R cpc cph gc gh
global etad etac etab etat etamech etaAB etan

% Gas properties...
R = 1716; % ft-lb/slug/R
cpc = 6010; % ft-lb/slug/R
cph = 6578; % ft-lb/slug/R
gc = 1.4;
gh = 1.33;

% Define component efficiencies...
etad = 0.90;
etac = 0.85;
etab = 0.98;
etat = 0.9;
etamech = 1;
etaAB = 1;
etan = 0.97;

% Define component pressure ratios...
pid = 1;
pic = [2:6 8:2:10 15:5:20];
pi b = 0.97;
pin = 1;

% Other inputs...
MO = 0.85;
h = 33200; % ft
mdot = 100; % lbm/sec
TT4array = [1800 1400 1000]*1.8 % deg R
Hf = 18500; % BTU/lbm

% Unit conversions...
mdot = mdot/32.2; % slug/sec
Hf = Hf*778.2*32.2; % ft-lb/slug

for k=1:length(TT4array)
    TT4 = TT4array(k)
    [Tnet Tspec TSFC etap etath etao]=turbojet(MO, h, mdot, TT4, pid, pic, pi b, pin, Hf)
    Tspecdata(k,:) = Tspec(:);
    TSFCdata(k,:) = TSFC(:);
end

figure
set(gcf, 'color', 'white', 'position', [200 200 700 700])
subplot(2,1,1)
plot(pic, Tspecdata(1,:), ':k', pic, Tspecdata(2,:), '-b', pic, Tspecdata(3,:), '--r')
% legend('TT4=1000 K', 'TT4=1400 K', 'TT4=1800 K', 'best')
xlabel('\pi_c=p_{T3}/p_{T2}')
ylabel('T/mdot (ft/sec)')
subplot(2,1,2)
plot(pic, TSFCdata(1,:), ':k', pic, TSFCdata(2,:), '-b', pic, TSFCdata(3,:), '--r')
legend('T_{T4}=1000 K', 'T_{T4}=1400 K', 'T_{T4}=1800 K', 'best')
xlabel('\pi_c=p_{T3}/p_{T2}')
ylabel('TSFC (lbm/lbf/hr)')

```

```

pic =      2      3      4      5      6      8      10      15      20
TT4array =      3240      2520      1800
TT4 =      3240
f =
    0.0411    0.0400    0.0391    0.0383    0.0377    0.0366    0.0357    0.0339    0.0325
PRcrit =
    0.5404
PRexit =
    0.3726    0.2758    0.2250    0.1933    0.1716    0.1435    0.1261    0.1019    0.0895
M7 =
    1      1      1      1      1      1      1      1      1
V7 =

```