PROGRAMMING ASSIGNMENT I

MEC 320

WBT (Fahrenheit)	70.0
HL	1154
CP	2.26
NHR	8051
NKW	248824
CWT	83.8
CR	15.9

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Introduction

In this assignment, a turbine "cold-end" system as shown as figure 1 is to be discussed.

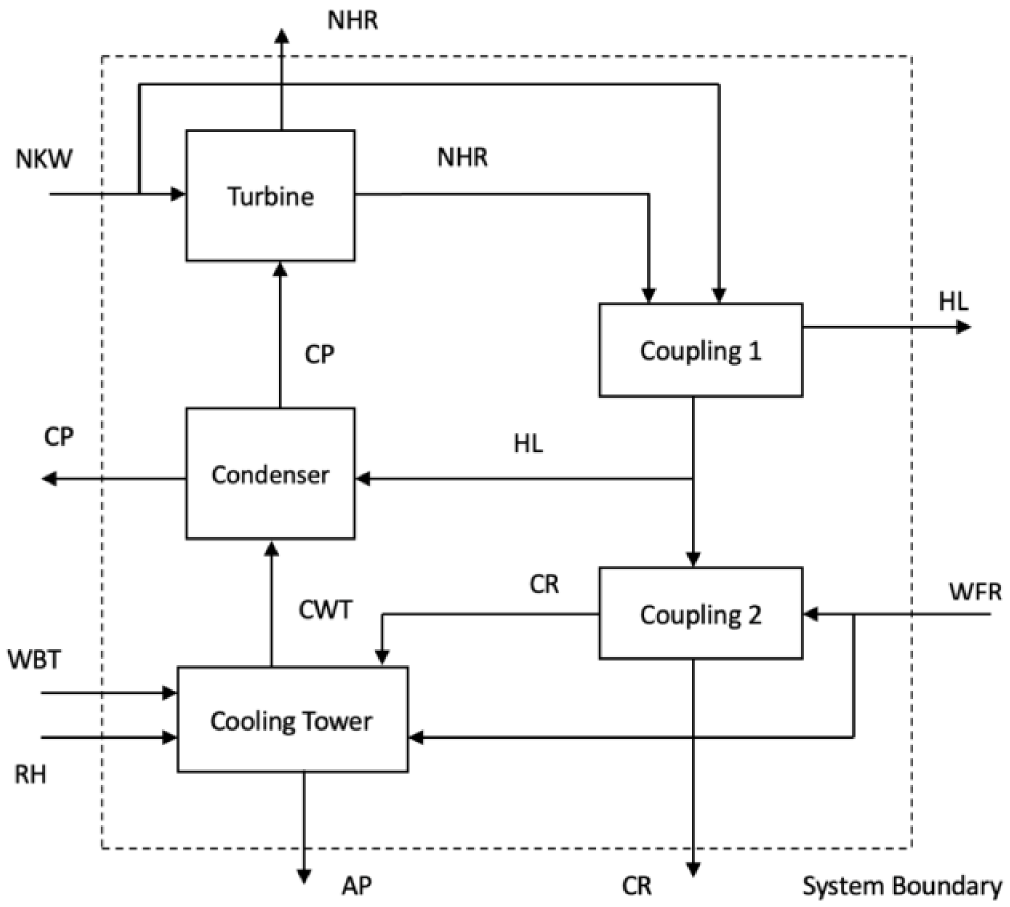

Figure 1 Simulation structure diagram for a turbine cold-end system. [1]

There are 9 parameters that would affect the performance of the turbine, which are

1. NKW = turbine net output
2. NHR = turbine net heat rate
3. CP = condenser pressure

4. CWT = cold water temperature

5. HL = heat load

6. WBT = ambient wet-bulb temperature

7. CR = cooling range

8. WFR = cooling water flow rate

9. RH = ambient relative humidity

For the 250 MW unit discussed, "the turbine performance data with the maximum steam throttle flow can be approximated [1]" by the following equations.

$$\mathrm{NHR} = -45.19(\mathrm{CP})^4 + 420(\mathrm{CP})^3 - 1442(\mathrm{CP})^2 + 2248(\mathrm{CP}) + 6666 \tag{1}$$

$$NKW = 4{,}883(CP)^4 - 44{,}890(CP)^3 + 152{,}600(CP)^2 - 231{,}500(CP) + 383{,}400 \tag{2}$$

The condenser pressure CP can be determined by

$$\begin{aligned}\mathrm{CP} = 1.6302 &- 0.50095 \times 10^{(-1)}(\mathrm{CWT}) + 0.55796 \times 10^{(-3)}(\mathrm{CWT})^2 \\ &+ 0.32946 \times 10^{(-3)}(\mathrm{HL}) - 0.10229 \times 10^{(-4)}(\mathrm{HL})(\mathrm{CWT}) \\ &+ 0.16253 \times 10^{(-6)} \times (\mathrm{HL})(\mathrm{CWT})^2 + 0.42658 \times 10^{(-6)}(\mathrm{HL})^2 \\ &- 0.92331 \times 10^{(-8)}(\mathrm{HL})^2(CWT) \\ &+ 0.71265 \times 10^{(-10)} \times (\mathrm{HL})^2(CWT)^2\end{aligned} \tag{3}$$

when cooling water flow rate (WFR) is in 145000 GPM. In addition, the cold-water temperature (CWT) of a d mechanical-draft cooling tower is

$$\begin{aligned}\mathrm{CWT} = {} & -0.10046 \times 10^{2} + 0.22801 \times 10^{(-3)}(\mathrm{WFR}) + 0.85396(\mathrm{CR}) \\ & + 0.18617 \times 10^{(-5)}(\mathrm{CR})(\mathrm{WFR}) + 0.10957 \times 10^{1}(WBT) \\ & - 0.22425 \times 10^{(-5)}(\mathrm{WBT})(\mathrm{WFR}) - 0.11978 \times 10^{(-1)}(\mathrm{WBT})(\mathrm{CR}) \\ & + 0.14378 \times 10^{(-7)}(\mathrm{WBT})(\mathrm{CR})(\mathrm{WFR})\end{aligned} \tag{4}$$

when assuming the circulating-water flow rate is 145,000 GPM [1]. Moreover, the heat load of the condenser is equal to the heat load of the cooling tower, which gives

$$\mathrm{CR} = 2000\frac{\mathrm{HL}}{\mathrm{WFR}} \tag{5}$$

On the other hand, from energy conservation, if neglecting the heat loss of the system, the waste heat emitted by the turbine is equal to the heat removed by the condenser. That is,

$$\mathrm{HL} = \frac{\mathrm{NKW}(\mathrm{NHR} - 3412)}{10^{6}} \tag{6}$$

Notice that all 6 equations are in English unit. From equation (1) to (6), we could solve for to following 6 variables of the given system under various ambient wet-bulb temperatures (WBT).

1. Heat load (HL)
2. Condenser pressure (CP)
3. Turbine net heat rate (NHR)
4. Turbine net output (NKW)
5. Tower approach (CWT)
6. Tower cooling range (CR)

Assumptions

To solve problem, I assume there are no heat loss in the system to fulfill equation (6). Secondly, equation (4) is only valid when cooling water flow rate (WFR) is 145000 GPM, so I assume the circulating-water flow of the system rate is 145000 GPM for all time. That is, equation (4) is reduced to

$$\begin{aligned}\mathrm{CWT} = {} & -0.10046 \times 10^{2} + 33.06145 + 0.85396(\mathrm{CR}) + 0.2699465 \times (\mathrm{CR}) \\ & + 0.10957 \times 10^{1}(WBT) - 0.3251625(\mathrm{WBT}) \\ & - 0.11978 \times 10^{(-1)}(\mathrm{WBT})(\mathrm{CR}) + 2.08481 \times 10^{(-3)}(\mathrm{WBT})(\mathrm{CR})\end{aligned} \tag{7}$$

and equation (5) is reduced to

$$\mathrm{CR} = 2000\,\frac{\mathrm{HL}}{145000} \tag{8}$$

The problem is complex and difficult to solve by hand; In this report, the solution would be generated numerically using Newton-Raphson method [2]. Since equation (1) contains a minimum significant digits of 3 digits, the error I set for the Newton-Raphson method is 0.05%.

The goal of the problem is to estimate the performance of the system under various ambient wet-bulb temperatures (WBT); In practice, I set the range of the ambient wet-bulb temperature as

$$\text{ambient wet bulb temperature range} = 32.0^{o}F \sim 122.0^{o}F \tag{9}$$

base on the same scale of a published research paper analyzing the historical outdoor wet-bulb temperature data in temperate to hot climates [3]. The result will be calculated through the given range of WBT numerically with the step of $1^{o}F$.

Calculation

For Newton-Raphson method, equation 1, 2, 3, 6,7 and 8 are rewritten as

$$\begin{aligned} f_1(\mathrm{HL}, \mathrm{CP}, \mathrm{NHR}, \mathrm{NKW}, \mathrm{CWT}, \mathrm{CR}) \\ &= -45.19(\mathrm{CP})^4 + 420(\mathrm{CP})^3 - 1442(\mathrm{CP})^2 + 2248(\mathrm{CP}) - \mathrm{NHR} \\ &+ 6666 \end{aligned} \tag{10}$$

$$f_2(\mathrm{HL}, \mathrm{CP}, \mathrm{NHR}, \mathrm{NKW}, \mathrm{CWT}, \mathrm{CR})$$
$$= 4{,}883(CP)^4 - 44{,}890(CP)^3 + 152{,}600(CP)^2 - 231{,}500(CP) - \mathrm{NKW} + 383{,}400 \tag{11}$$

$$f_3(\mathrm{HL}, \mathrm{CP}, \mathrm{NHR}, \mathrm{NKW}, \mathrm{CWT}, \mathrm{CR})$$
$$= 1.6302 - \mathrm{CP} - 0.50095 \times 10^{(-1)}(\mathrm{CWT}) + 0.55796 \times 10^{(-3)}(\mathrm{CWT})^2 + 0.32946 \times 10^{(-3)}(\mathrm{HL}) - 0.10229 \times 10^{(-4)}(\mathrm{HL})(\mathrm{CWT}) + 0.16253 \times 10^{(-6)} \times (\mathrm{HL})(\mathrm{CWT})^2 + 0.42658 \times 10^{(-6)}(\mathrm{HL})^2 - 0.92331 \times 10^{(-8)}(\mathrm{HL})^2(CWT) + 0.71265 \times 10^{(-10)} \times (\mathrm{HL})^2(CWT)^2 \tag{12}$$

$$f_4(\mathrm{HL}, \mathrm{CP}, \mathrm{NHR}, \mathrm{NKW}, \mathrm{CWT}, \mathrm{CR}, \mathrm{WBT})$$
$$= -0.10046 \times 10^2 + 33.06145 + 0.85396(\mathrm{CR}) + 0.2699465 \times (\mathrm{CR}) + 0.10957 \times 10^1(WBT) - 0.3251625(\mathrm{WBT}) - 0.11978 \times 10^{(-1)}(\mathrm{WBT})(\mathrm{CR}) + 2.08481 \times 10^{(-3)}(\mathrm{WBT})(\mathrm{CR}) - \mathrm{CWT} \tag{13}$$

Notice the goal is to find the turbine performance under various WBT, so the WBT in equation (13) are a given constant for each calculation.

$$\mathrm{f}_5(\mathrm{HL}, \mathrm{CP}, \mathrm{NHR}, \mathrm{NKW}, \mathrm{CWT}, \mathrm{CR}) = 2000\frac{\mathrm{HL}}{145000} - \mathrm{CR} \tag{14}$$

$$\mathrm{f}_6(\mathrm{HL}, \mathrm{CP}, \mathrm{NHR}, \mathrm{NKW}, \mathrm{CWT}, \mathrm{CR}) = \frac{\mathrm{NKW}(\mathrm{NHR} - 3412)}{10^6} - \mathrm{HL} \tag{15}$$

The partial derivative of each variables for equation (9) to (16) are

$$\frac{\partial f_1}{\partial HL} = 0 \tag{16}$$

$$\frac{\partial \mathrm{f}_1}{\partial \mathrm{CP}} = -(4519 * \mathrm{CP}^3)/25 + 1260 * \mathrm{CP}^2 - 2884 * \mathrm{CP} + 2248 \tag{17}$$

$$\frac{\partial f_1}{\partial NHR} = -1 \tag{18}$$

$$\frac{\partial f_1}{\partial NKW} = 0 \tag{19}$$

$$\frac{\partial f_1}{\partial CWT} = 0 \tag{20}$$

$$\frac{\partial f_1}{\partial CR} = 0 \tag{21}$$

$$\frac{\partial f_2}{\partial HL} = 0 \tag{22}$$

$$\frac{\partial f_2}{\partial CP} = 19532 * \mathrm{CP}^3 - 134670 * \mathrm{CP}^2 + 305200 * \mathrm{CP} - 231500$$

(23)

$$\frac{\partial f_2}{\partial NHR} = 0$$

(24)

$$\frac{\partial f_2}{\partial NKW} = -1$$

(25)

$$\frac{\partial f_2}{\partial CWT} = 0$$

(26)

$$\frac{\partial f_2}{\partial CR} = 0$$

(27)

$$\begin{aligned}\frac{\partial f_3}{\partial HL} = 0.32946 \times 10^{(-3)} - 0.10229 \times 10^{(-4)}(\mathrm{CWT}) \\ + 0.16253 \times 10^{(-6)} \times (\mathrm{CWT})^2 + 0.85316 \times 10^{(-6)}(\mathrm{HL}) \\ - 1.84662 \times 10^{(-8)}(HL)(CWT) \\ + 1.42530 \times 10^{(-10)} \times (\mathrm{HL})(CWT)^2\end{aligned}$$

(28)

$$\frac{\partial f_3}{\partial CP} = -1$$

(29)

$$\frac{\partial f_3}{\partial NHR} = 0$$

(30)

$$\frac{\partial f_3}{\partial NKW} = 0$$

(31)

$$\frac{\partial f_3}{\partial CWT} = -0.50095 \times 10^{(-1)} + 1.11592 \times 10^{(-3)}(\mathrm{CWT}) - 0.10229 \times 10^{(-4)}(\mathrm{HL})$$
$$+ 0.32506 \times 10^{(-6)} \times (\mathrm{HL})(\mathrm{CWT}) - 0.92331 \times 10^{(-8)}(\mathrm{HL})^2$$
$$+ 1.42530 \times 10^{(-10)} \times (\mathrm{HL})^2(\mathrm{CWT})$$

(32)

$$\frac{\partial f_3}{\partial CR} = 0$$

(33)

$$\frac{\partial f_4}{\partial HL} = 0$$

(34)

$$\frac{\partial f_4}{\partial CP} = 0$$

(35)

$$\frac{\partial f_4}{\partial NHR} = 0$$

(36)

$$\frac{\partial f_4}{\partial NKW} = 0$$

(37)

$$\frac{\partial f_4}{\partial CWT} = -1$$

(38)

$$\frac{\partial f_4}{\partial CR} = 0.85396 + 0.2699465 - 0.11978 \times 10^{(-1)}(\mathrm{WBT}) + 2.08481 \times 10^{(-3)}(\mathrm{WBT}) \quad (39)$$

$$\frac{\partial f_5}{\partial HL} = \frac{2}{145} \quad (40)$$

$$\frac{\partial f_5}{\partial CP} = 0 \quad (41)$$

$$\frac{\partial f_5}{\partial NHR} = 0 \quad (42)$$

$$\frac{\partial f_5}{\partial NKW} = 0 \quad (43)$$

$$\frac{\partial f_5}{\partial CWT} = 0 \quad (44)$$

$$\frac{\partial f_5}{\partial CR} = -1 \quad (45)$$

$$\frac{\partial f_6}{\partial HL} = -1 \quad (46)$$

$$\frac{\partial f_6}{\partial CP} = 0 \quad (47)$$

$$\frac{\partial f_6}{\partial NHR} = \frac{NKW}{1000000}$$

(48)

$$\frac{\partial f_6}{\partial NKW} = \frac{NHR}{1000000} - \frac{853}{250000}$$

(49)

$$\frac{\partial f_6}{\partial CWT} = 0$$

(50)

$$\frac{\partial f_6}{\partial CR} = 0$$

(51)

With equation (16) to (51), the Jacobian matrix (J) is determined [2]. Then the provided MATLAB code (see appendix) is used to calculate the result.

For the first calculation of computing HL, CP, NHR, NKW, CWT, CR when WBT=$32.0^{o}F$, I apply the initial guess

HL=1000;

CP=1;

NHR=8000;

NKW=250000;

CWT=50;

CR=10;

(52)

The first initial guess shown in equation (52) comes from almost pure guessing. I first let CR=10 and CP=1 then apply this into equation (1), (2), and (6) in order to determine a vague range for NHR, NKW, and HL. I guess CWT=50 since it is a fair ambient temperature value. Because the description of this project did not include the unit of most of the variables, it is difficult to assign a better initial guess using physical conditions. For other wet-bulb temperatures, the initial guess is the result from the previous WBT computation.

Result

Using the provided MATLAB code (see appendix), I get the result of HL, CP, NHR, NKW, CWT, CR under varies WBT. Partial results for WBT from 32.0 to 42.0^oF are shown in table 1.

WBT (Fahrenheit)	32.0	33.0	34.0	35.0	36.0	37.0	38.0	39.0	40.0	41.0	42.0
HL	1163	1163	1162	1161	1161	1160	1159	1159	1158	1158	1157
CP	1.18	1.19	1.21	1.23	1.25	1.26	1.28	1.30	1.33	1.35	1.37
NHR	7912	7917	7922	7927	7932	7937	7941	7946	7951	7956	7960
NKW	258554	258112	257672	257238	256809	256388	255975	255572	255180	254799	254431
CWT	60.6	61.2	61.8	62.4	63.0	63.7	64.3	64.9	65.5	66.1	66.7
CR	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0

Table 1 Partial results for WBT from 32.0 to 42.0^oF

The value of parameters HL, CP, NHR, NKW, CWT, CR when WBT is 70.0^oF is shown below in table 2.

WBT (Fahrenheit)	70.0
HL	1154
CP	2.26
NHR	8051
NKW	248824
CWT	83.8
CR	15.9

Table 2 Results of HL, CP, NHR, NKW, CWT, CR when WBT is $70.0^o F$

The heat load (HL) of the system under various ambient wet-bulb temperatures (WBT) is

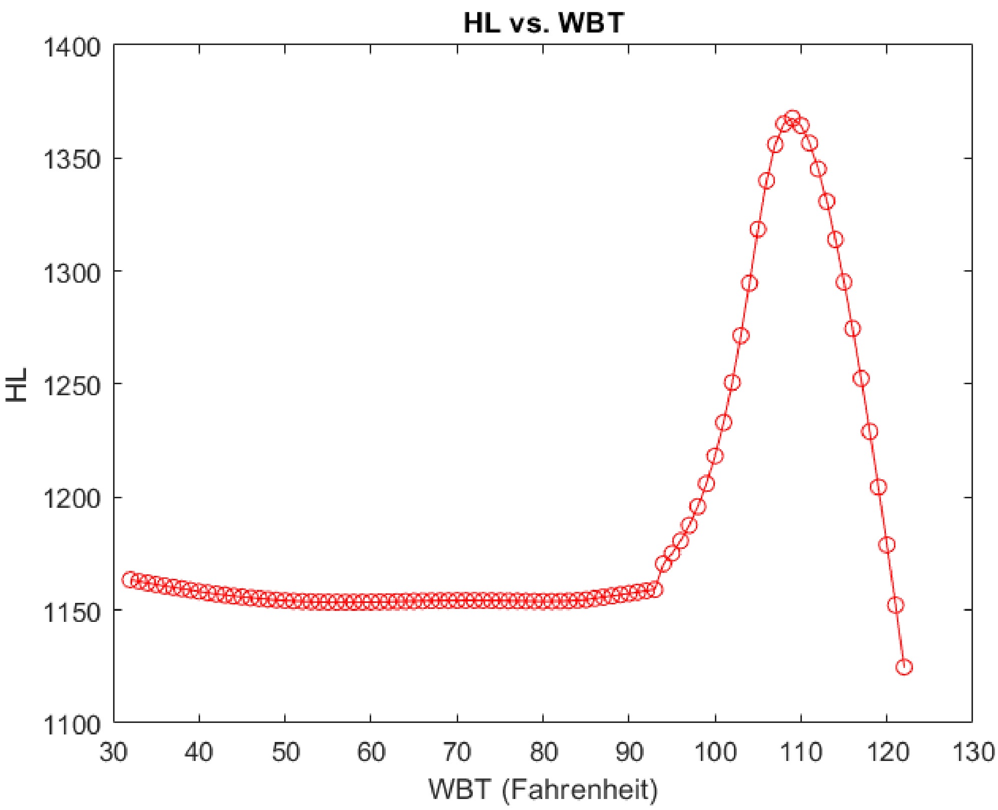

Figure 2 The heat load (HL) of the system under various ambient wet-bulb temperatures (WBT)

The condenser pressure (CP) of the system under various ambient wet-bulb temperatures (WBT) is

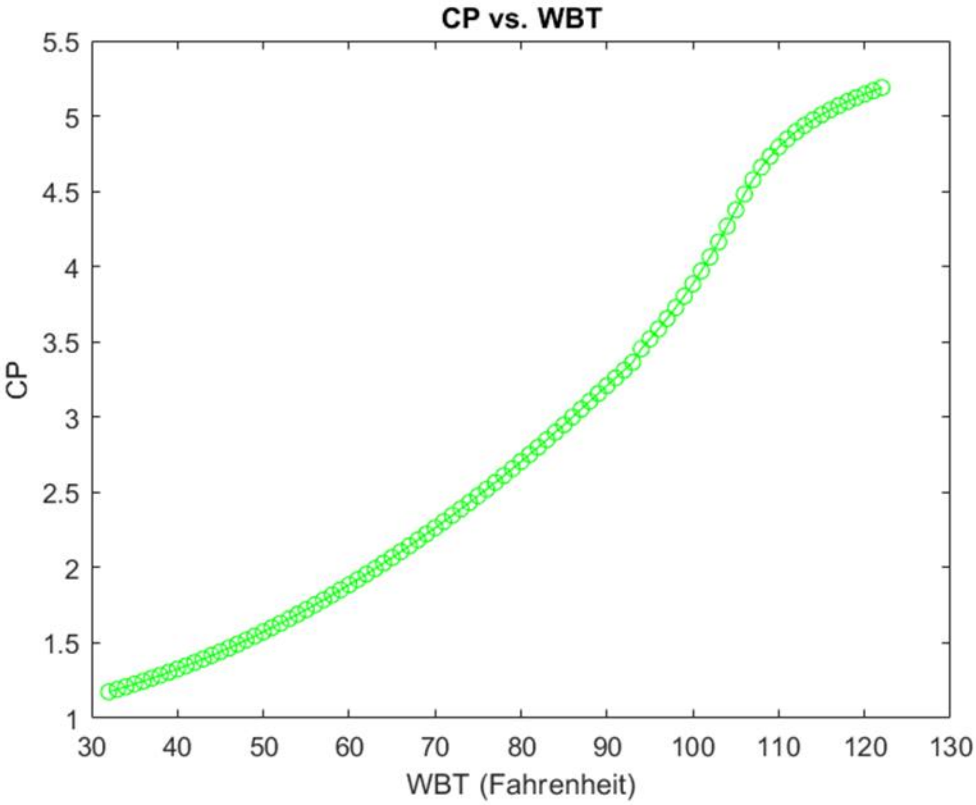

Figure 3 The condenser pressure (CP) of the system under various ambient wet-bulb temperatures

The turbine net heat rate (NHR) of the system under various ambient wet-bulb temperatures (WBT) is

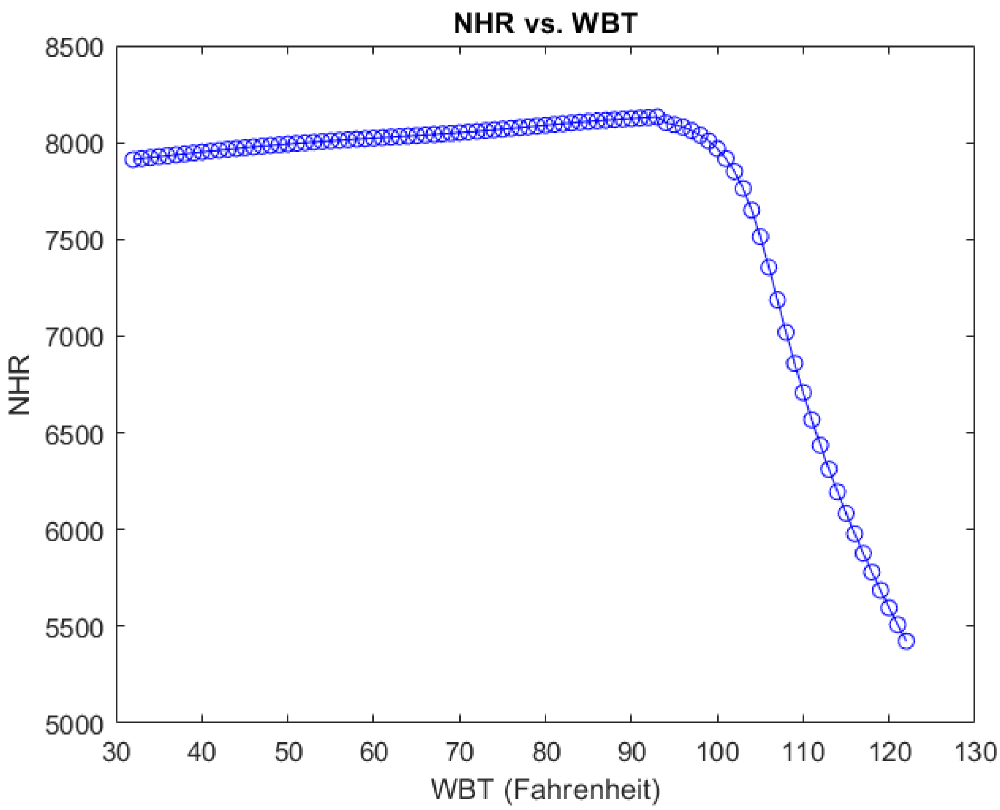

Figure 4 The turbine net heat rate (NHR) of the system under various ambient wet-bulb temperatures

The turbine net output (NKW) of the system under various ambient wet-bulb temperatures (WBT) is

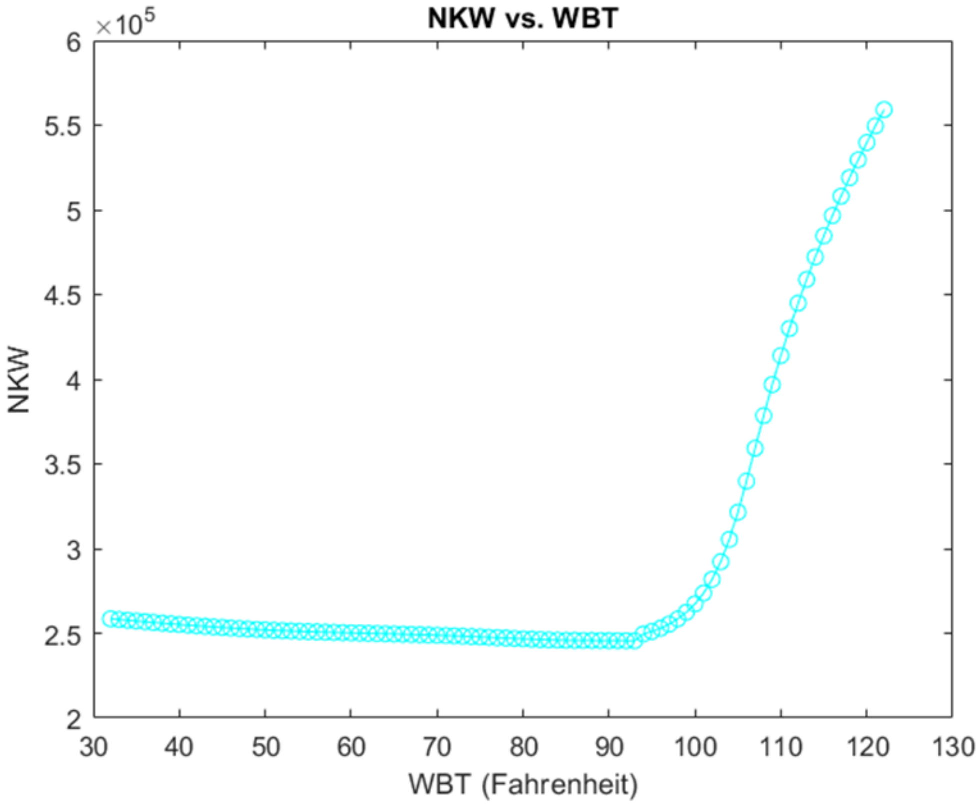

Figure 5 The turbine net output (NKW) of the system under various ambient wet-bulb temperatures

The tower approach (CWT) of the system under various ambient wet-bulb temperatures

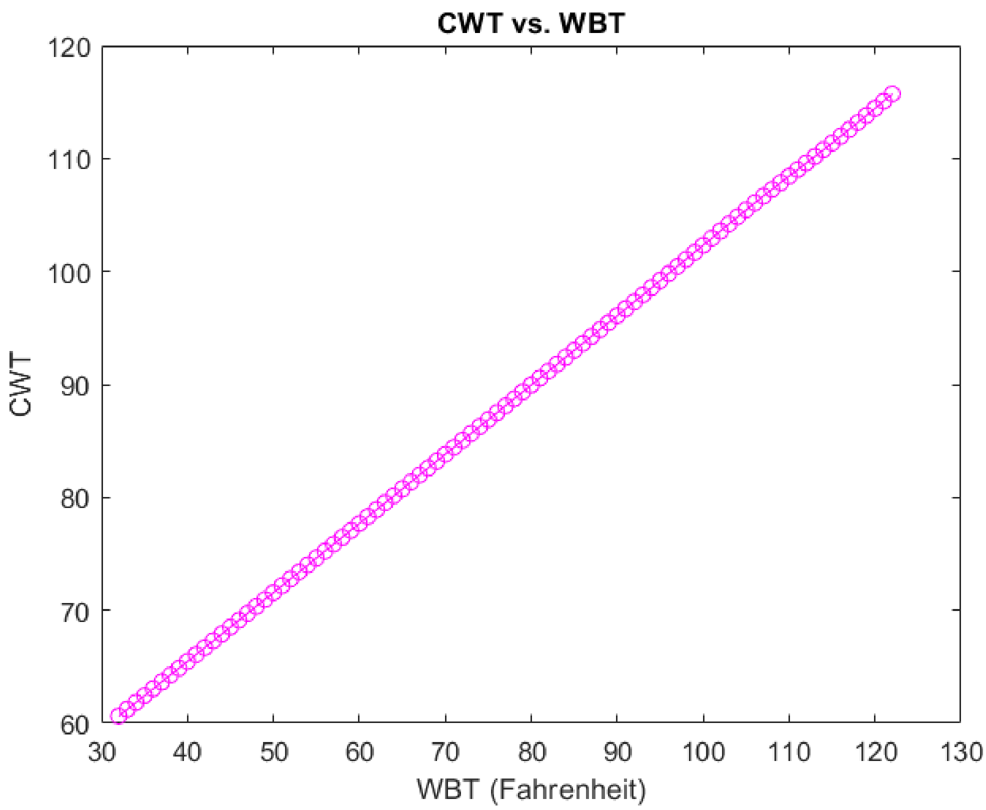

Figure 6 The tower approach (CWT) of the system under various ambient wet-bulb temperatures

The tower cooling range (CR) of the system under various ambient wet-bulb temperatures (WBT)

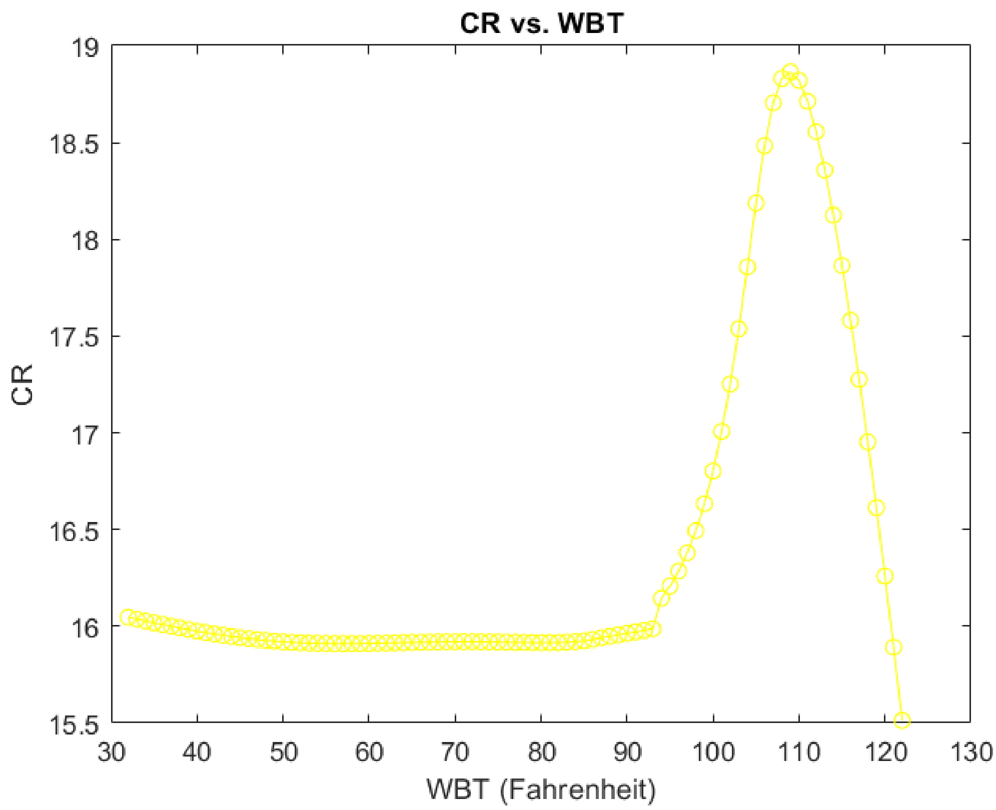

Figure 7 The tower cooling range (CR) of the system under various ambient wet-bulb temperatures

Discussion

The heat load (HL) and tower cooling range (CR) of the system has a peak when WBT is around $110^{o}F$. As figure 2, 4, 5 and 7 shown, the value of HL, NHR, NKW and CR varies with WBT the most when WBT rang from $90.0^{o}F \sim 120.0^{o}F$. All results of HL fall in the range of 1100 to 1400; CP falls in the range of 1 to 5.5; NHR falls in the range of 5000 to 8500; NKW falls in the range of 200000 to 1000000; CWT falls in the range of 60 to 120; CR falls in the range of 14 to 19. Compare with the initial guesses shown in equation (49), the results fall in the same order of the guesses. Since the description of this project [1] did not specify the unit of most of the variables, it is difficult to further interpret the result to physical meaning.

When WBT is $70.0^{o}F$, the result of HL, CP, NHR, NKW, CWT, CR values are shown in table 2. By substituting this result back to equation (10) to (15), we get

$$\mathrm{f}_1 = -0.4429 \tag{53}$$

$$\mathrm{f}_2 = 18.2316 \tag{54}$$

$$\mathrm{f}_3 = 0.0028 \tag{55}$$

$$\mathrm{f}_4 = 0.0121 \tag{56}$$

$$\mathrm{f}_5 = 0.0172 \tag{57}$$

$$\mathrm{f}_6 = 0.2945 \tag{58}$$

Except equation (54), Equation (53) to (58) are really close to zero. Since the allowing error is stated to be in only 3 significant digits, but the computed NKW carries 6 digits from the units digit, it fair to concluded that the result of the Newton-Raphson method solves the problem well within the error.

Conclusion

When WBT is $70.0^{o}F$, HL is 1154; CP is 2.26; NHR is 8051; NKW is 248824; CWT is 83.8; CR is 15.9, which fulfills the given equations of the problem within the error. The result of the heat load (HL), condenser pressure (CP), turbine net heat rate (NHR), turbine net output (NKW), tower approach (CWT), and tower cooling range (CR) of the given system under ambient wet-bulb temperatures (WBT) rang from $32.0^{o}F \sim 122.0^{o}F$ is shown in figure 2 to 7. The value of HL, NHR, NKW and CR varies with WBT the most when WBT rang from $90.0^{o}F \sim 120.0^{o}F$. The heat load (HL) and tower cooling range (CR) of the system has a peak when WBT is around $110^{o}F$. The most difficult of this project for me is that the description of this project did not specify the unit of most of the variables. This makes the initial guess harder and difficult to write the discussing base on physical conditions.

Appendix (the MATLAB source code)

```
clc;
syms HL CP NHR NKW CWT CR WBT
%Enter f1 (equation 10) to f6 (equation 15)
f1=-45.19*(CP)^4+420*(CP)^3-1442*(CP)^2+2248*(CP)-NHR+6666;
f2=4883*(CP)^4-44890*(CP)^3+152600*(CP)^2-231500*(CP)-NKW+383400;
```

```
f3=1.6302-CP-0.50095*((10)^(-1))*(CWT)+0.55796*(10)^(-
3)*(CWT)^2+0.32946*(10)^(-3)*(HL)-0.10229*(10)^(-
4)*(HL)*(CWT)+0.16253*(10)^(-6)*(HL)*(CWT)^2+0.42658*(10)^(-6)*(HL)^2-
0.92331*(10)^(-8)*(HL)^2*(CWT)+0.71265*(10)^(-10)*(HL)^2*(CWT)^2;
f4=-
0.10046*(10)^2+33.06145+0.85396*(CR)+0.2699465*(CR)+0.10957*(10)^1*(WBT)-
0.3251625*(WBT)-0.11978*(10)^((-1))*(WBT)*(CR)+2.08481*(10)^((-
3))*(WBT)*(CR)-CWT;
f5=2000*HL/145000-CR;
f6=((NKW)*(NHR-3412))/10^6-HL;

%The partial derivative of each variables for f1 to f6 (refer to equation
16 to equation 51 in the report)
%equation 16 to equation 21
df1dhl=0;
df1dcp=- (4519*CP^3)/25 + 1260*CP^2 - 2884*CP + 2248;
df1dnhr=-1;
df1dnkw=0;
df1dcwt=0;
df1dcr=0;

%equation 22 to equation 27
df2dhl=0;
df2dcp=19532*CP^3 - 134670*CP^2 + 305200*CP - 231500;
df2dnhr=0;
df2dnkw=-1;
df2dcwt=0;
df2dcr=0;

%equatiom 28 to 33
df3dhl=0.32946*(10)^((-3))-0.10229*(10)^((-4))*(CWT)+0.16253*(10)^((-
6))*(CWT)^2+0.85316*(10)^((-6))*(HL)-1.84662*(10)^((-
8))*(HL)*(CWT)+1.42530*(10)^((-10))*(HL)*(CWT)^2;
df3dcp=-1;
df3dnhr=0;
df3dnkw=0;
```

```
df3dcwt=-0.50095*(10)^((-1))+1.11592*(10)^((-3))*(CWT)-0.10229*(10)^((-
4))*(HL)+0.32506*(10)^((-6))*(HL)*(CWT)-0.92331*(10)^((-
8))*(HL)^2+1.42530*(10)^((-10))*(HL)^2*(CWT);
df3dcr=0;

%equatiom 34 to 39
df4dhl=0;
df4dcp=0;
df4dnhr=0;
df4dnkw=0;
df4dcwt=-1;
df4dcr=0.85396+0.2699465-0.11978*(10)^((-1))*(WBT)+2.08481*(10)^((-
3))*(WBT);

%equatiom 40 to 45
df5dhl=2/145;
df5dcp=0;
df5dnhr=0;
df5dnkw=0;
df5dcwt=0;
df5dcr=-1;

%equatiom 46 to 51
df6dhl=-1;
df6dcp=0;
df6dnhr=NKW/1000000;
df6dnkw=NHR/1000000 - 853/250000;
df6dcwt=0;
df6dcr=0;

%Jacobian matrix J
J=[df1dhl,df1dcp,df1dnhr,df1dnkw,df1dcwt,df1dcr;
    df2dhl,df2dcp,df2dnhr,df2dnkw,df2dcwt,df2dcr;
    df3dhl,df3dcp,df3dnhr,df3dnkw,df3dcwt,df3dcr;
    df4dhl,df4dcp,df4dnhr,df4dnkw,df4dcwt,df4dcr;
    df5dhl,df5dcp,df5dnhr,df5dnkw,df5dcwt,df5dcr;
    df6dhl,df6dcp,df6dnhr,df6dnkw,df6dcwt,df6dcr;];
```

```
%Set initial guesses
hl=1000;
cp=1;
nhr=8000;
nkw=250000;
cwt=50;
cr=10;

%set error
errs=0.0005;

%initiallize matrixs
B=zeros(6,1);
Xm=[hl;cp;nhr;nkw;cwt;cr];
Xm1=zeros(6,1);
ResultMatrix=zeros(7,91);
ResultMatrix(1,:)=32:1:122; %set desire WBT range
Xmt=transpose(Xm);
iter=1;


for wbt=32:1:122 %set desire WBT range
    f4s=subs(f4,WBT,wbt);
    for i=1:100 %Applying Newton-Raphson method
        Jm=double(subs(J,[HL CP NHR NKW CWT CR WBT],[Xmt,wbt]));
        B(:,:)=double(-1.*[(subs(f1,[HL CP NHR NKW CWT CR],Xmt));
            (subs(f2,[HL CP NHR NKW CWT CR],Xmt));
            (subs(f3,[HL CP NHR NKW CWT CR],Xmt));
            (subs(f4s,[HL CP NHR NKW CWT CR],Xmt));
            (subs(f5,[HL CP NHR NKW CWT CR],Xmt));
            (subs(f6,[HL CP NHR NKW CWT CR],Xmt));
            ]);
        deltaXm=Jm\B;
        Xm1=Xm+deltaXm;

        %calculate error for current itteration
```

```
        temp=(Xm1-Xm).^2;
        temp2=Xm1.^2;
        err=(sum(temp))^0.5/sum(temp2)^0.5;

        %test convergent
        if double(err)<=errs
            ResultMatrix(2:7,iter)=Xm1; %save the estimate result for
current WBT
            break;
        end

        if i==100
             disp('diverage');
        end

        Xmt=transpose(Xm1);
        Xm=Xm1;
    end

    iter=iter+1;
end

%plot HL, CP, NHR, NKW, CWT, CR vs. WBT
fig1=figure('Name','HL vs. WBT');
plot(ResultMatrix(1,:),ResultMatrix(2,:),"Marker","o","Color","r");
title('HL vs. WBT')
xlabel('WBT (Fahrenheit)')
ylabel('HL')

fig2=figure('Name','CP vs. WBT');
plot(ResultMatrix(1,:),ResultMatrix(3,:),"Marker","o","Color","g");
title('CP vs. WBT')
xlabel('WBT (Fahrenheit)')
ylabel('CP')

fig3=figure('Name','NHR vs. WBT');
plot(ResultMatrix(1,:),ResultMatrix(4,:),"Marker","o","Color","b");
```

```
title('NHR vs. WBT')
xlabel('WBT (Fahrenheit)')
ylabel('NHR')

fig4=figure('Name','NKW vs. WBT');
plot(ResultMatrix(1,:),ResultMatrix(5,:),"Marker","o","Color","c");
title('NKW vs. WBT')
xlabel('WBT (Fahrenheit)')
ylabel('NKW')

fig5=figure('Name','CWT vs. WBT');
plot(ResultMatrix(1,:),ResultMatrix(6,:),"Marker","o","Color","m");
title('CWT vs. WBT')
xlabel('WBT (Fahrenheit)')
ylabel('CWT')

fig6=figure('Name','CR vs. WBT');
plot(ResultMatrix(1,:),ResultMatrix(7,:),"Marker","o","Color","y");
title('CR vs. WBT')
xlabel('WBT (Fahrenheit)')
ylabel('CR')
```

Reference

[1] Ladeinde, Foluso and Sharfuddin, A. Abdullah. *MEC 320 Programming Assignment I (Newton Raphson).*

[2] Ladeinde, Foluso. *MEC 320 Numerical Methods for Engineers ROOTS OF ALGEBRAIC EQUATIONS*

[3] Hall, Andrew, et al. "*Spatial analysis of outdoor wet bulb globe temperature under RCP4. 5 and RCP8. 5 scenarios for 2041–2080 across a range of temperate to hot*

climates." Weather and Climate Extremes 35 (2022): 100420.