1. Solution to problem 1

$$\triangle p = 240 \times 10^3 - 43.8 \times 10^2 Q^2 \tag{1}$$

$$\triangle p = 40 \times 10^3 + 156.2 \times 10^3 Q^{1.8} \tag{2}$$

Given

$$Q_{initisl} = 0.4$$

(5) can be re-written to calculate Q from $\triangle$ P

$$Q_i = \left(\frac{240 \times 10^3 - \triangle P}{43.8 \times 10^2} \right)^{0.5} \tag{3}$$

Eqns (3) and (2) can be used

$SINo.$	Q_i	$\triangle P_i$	Q_{i+1}
1	0.4	70018.50	6.22
2	6.22	4244514	i

So the information flow diagram assumed is not correct

Let's try the other way

$$Q_i = \left(\frac{\triangle P - 40 \times 10^3}{156.2 \times 10^3} \right)^{0.555} \tag{4}$$

$$\triangle p = 240 \times 10^3 - 43.8 \times 10^2 Q^2 \quad (5)$$

$SI No.$	Q_i	$\triangle P_i$	Q_{i+1}
1	0.4	239299	1.14
2	1.14	234273.12	1.12
3	1.12	234420.08	1.129
4	1.129	234415.41	1.129
5	1.129	234414.5	1.129

1.1. b

Electric power =

$$\triangle P \times Q$$

$$= 0.26 MW$$

When the efficiency is 86 percent

Electric power =

$$\frac{\triangle P \times Q}{0.86}$$

$$= 0.3 MW$$

2. Problem 2

Newton Raphson method for two variables

$$f1 = \triangle p - 240 \times 10^3 + 43.8 \times 10^2 Q^2$$

$$f2 = \triangle p - 40 \times 10^3 - 156.2 \times 10^3 Q^{1.8}$$

$$\frac{\partial f1}{\partial(\triangle P)} = 1$$

$$\frac{\partial f2}{\partial(\triangle P)} = 1$$

$$\frac{\partial f1}{\partial(Q)} = 87.6 \times 10^2 Q$$

$$\frac{\partial f2}{\partial(Q)} = -281.16 \times 10^3 Q^{0.8}$$

$$\begin{pmatrix} 1 & 87.6 \times 10^2 Q^2 \\ 1 & -281.16 \times 10^3 Q^{0.8} \end{pmatrix} \times \begin{pmatrix} \triangle p_{i+1} - \triangle p_i \\ Q_{i+1} - Q_i \end{pmatrix} = \begin{pmatrix} -f1 \\ -f2 \end{pmatrix} \tag{6}$$

Lets start with

$$Q_i = 0.4$$

$$\triangle p_i = 239300$$

$SNo.$	Q_i	$\triangle P_i$	f1	f2	$\frac{\partial f1}{\partial \triangle p}$	$\frac{\partial f2}{\partial \triangle p}$	$\frac{\partial f1}{\partial Q}$	$\frac{\partial f2}{\partial Q}$	$(Q_{i+1} - Q_i)$	$(\triangle p_{i+1} - \triangle p_i)$
1	0.4	239299	-0.2	169280	1	1	3504	-135083	1.2214	-4279
2	1.62	235019	6513.87	-177208	1	1	14191	-413585.73	-0.429	-420
3	1.19	234599	801.51	-19032	1	1	10424	-323140	-0.429	-420
4	1.13	234417.29								

Solution is

$$Q = 1.13, \triangle P = 234417.29$$

3. problem 3

$$0.52x + 0.2y + 0.25z = 4800 \tag{7}$$

$$0.3x + 0.5y + 0.2z = 5810 \tag{8}$$

$$0.18x + 0.3y + 0.55z = 5690 \tag{9}$$

Diagnol dominance is satisfied

Writing the above equations in terms of x,y and z

$$x = \frac{4800 - 0.2y - 0.25z}{0.52}$$
$$y = \frac{5810 - 0.3x - 0.2z}{0.5}$$
$$z = \frac{5690 - 0.18x - 0.3y}{0.55}$$

$SINo.$	x_i	y_i	z_i	sum of residuals
1	2000	2000	2000	-
2	7500	6320	4443.63	5.48×10^7
3	4663	7044.36	4976.79	8.8×10^6
4	4128.71	7152.05	5093.11	3×10^5
5	4031	7163.93	5118.94	10.15×10^3
6	4014.59	7163.84	5124.03	325.11
7	4011.96	7163.20	5125.24	10.23
8	4011.63	7162.92	5125.50	1.09
9	4011.61	7162.93	5125.94	0.23

4. problem 4

Exact fit using Newton's divided difference method

$$y = a_o + a_1(x - x_0) + a_2(x - x_0)(x - x_1) + a_3(x - x_0)(x - x_1)(x - x_2)$$

Upon substitution of the given data, the values of constants are as follows

$$a_0 = 22.5 \times 10^{-6}$$

$$a_1 = 1.48 \times 10^{-7}$$

$$a_2 = 2 \times 10^{-10}$$

$$a_3 = 1.906 \times 10^{-11}$$

at

$$x = 382K$$

$$y = 34.2 \times 10^{-6}$$

4.1. b

Quadratic interpolation

$$y = a_0 + a_1 x + a_2 x^2$$

Upon substitution of the given data, the values of constants are as follows

$$a_0 = -9 \times 10^{-7}$$

$$a_1 = 1.8 \times 10^{-8}$$

$$a_2 = 2 \times 10^{-10}$$

at

$$x = 382K$$

$$y = 35.15 \times 10^{-6}$$

5. problem 5

Second order Lagrange polynomial

$$y = \frac{(x-x_1)(x-x_2)}{(x_0-x_1)(x_0-x_2)}y_0 + \frac{(x-x_0)(x-x_2)}{(x_1-x_0)(x_1-x_2)}y_1 + \frac{(x-x_0)(x-x_1)}{(x_2-x_0)(x_2-x_1)}y_2$$

Upon substitution of the given data, the values of constants are as follows Taking the last three datas for the fit

Y at x= 416

$$= 41.06 \times 10^{-6}$$

5.1. b

The linear interpolation yields

Y at x= 416

$$= 41.15 \times 10^{-6}$$