

REFERENCES

1. Raju, K.S.N., and Jaqdish, C., " Consider the Plate Heat Exchanger ", Chem. Eng. , 87(16), 123-144, 1980.
2. Walker, G., Industrial Heat Exchanger Basic Guide, McGraw-Hill Co., New York, 1982.
3. Marriot, J., and Alfa-LavalAB, " Where and How To Use Plate Heat Exchangers", Chem. Eng., 78(8), 156-162, 1971.
4. Usher, J.D., and A. Cooper, et al., Heat Exchanger Design Handbook: Thermal and Hydrulic Design of Heat Exchangers, pp. 3.7.1- 3.7.12, McGraw-Hill Co., 1981.
5. James, R. W., Engineering Heat Transfer SI Version, pp. 12-17, John Wiley & Son Inc., 1978.
6. Kakaz, S., A.E. Bergles, and F.Mayingier, Heat Exchangers Thermal-Hydraulic Fundamentals and Design, pp. 432-439, McGraw-Hill Co., 1981.
7. Tanthapanichakool, W., Heat Exchanger, pp. 69, Technological Promotion Association(Thai- Japan), 1st ed., 1983.
8. Bassiouny, M.K., and H.Martin, " Temperature Distribution in a Four Channel Plate Heat Exchanger ", Heat transfer engineering, 6(2), 58-72, 1985.
9. James R. W., Charles E. W., and Robert E. W., Fundamentals of Momentum, Heat and Mass Transfer, pp. 43-47, John Wiley & Son Inc., 1969.
10. Watson, E.L., A.A.Mckillop, W.L.Dunkley, and R.L.Perry, " Plate Heat Exchangers ", Industrial and Engineering Chemistry, 52(9), 733-739, 1960.

- 52(9), 733-739, 1960.
11. Bassiouny, M.K., and H.Martin, " Flow Distribution and Pressure Drop in Plate Heat Exchanger-I U-Type arrangement ", Chem. Engng Sci., 39(4), 693-700, 1984.
 12. Bassiouny, M.K., and H.Martin, " Flow Distribution and Pressure Drop in Plate Heat Exchanger-II Z-Type arrangement ", Chem. Engng Sci., 39(4), 701-704, 1984.
 13. Cooper, A., J.W. Sutor and J.D. Usher, " Cooling Water Fouling Plate Heat Exchangers ", Sixth International Heat Transfer Conference, 4, 185-187, Hemisphere Pub. Co., New York, 1978.
 14. Mckillop, and W.L. Dunkley, " Heat Transfer (Plate Heat Exchanger)", Industrial and Engineering Chemistry, 52(9), pp. 740-744, 1960.
 15. Jackson, B.W., and R.A. Troupe, " Laminar Flow in a Plate Heat Exchanger ", Chem. Eng. Prog., 59(7), 57-61, 1963.
 16. Fock, W.W, " Selecting Optimum Plate Heat Exchanger Surface Patterns ", Journal of Heat Transfer, 108(2), 153-160, 1986.
 17. Buonopane, R.A., R.A. Troupe, and J.C. Morgen, " Heat Transfer Design Method for Plate Heat Exchangers ", Chem. Eng. Prog., 59(7), 57-61, 1963.
 18. Morriott, J., Alfa-Laval AB, " Performance of an Alfa Flax Plate Heat Exchanger ", Chem. Eng. Prog., 77(2), 73-78, 1977.
 19. Usher, J.D., et al., Heat Exchanger design Handbook: Mechanical Design of Plate Heat Exchangers, pp. 4.4.2, McGraw-Hill Co., 1981.

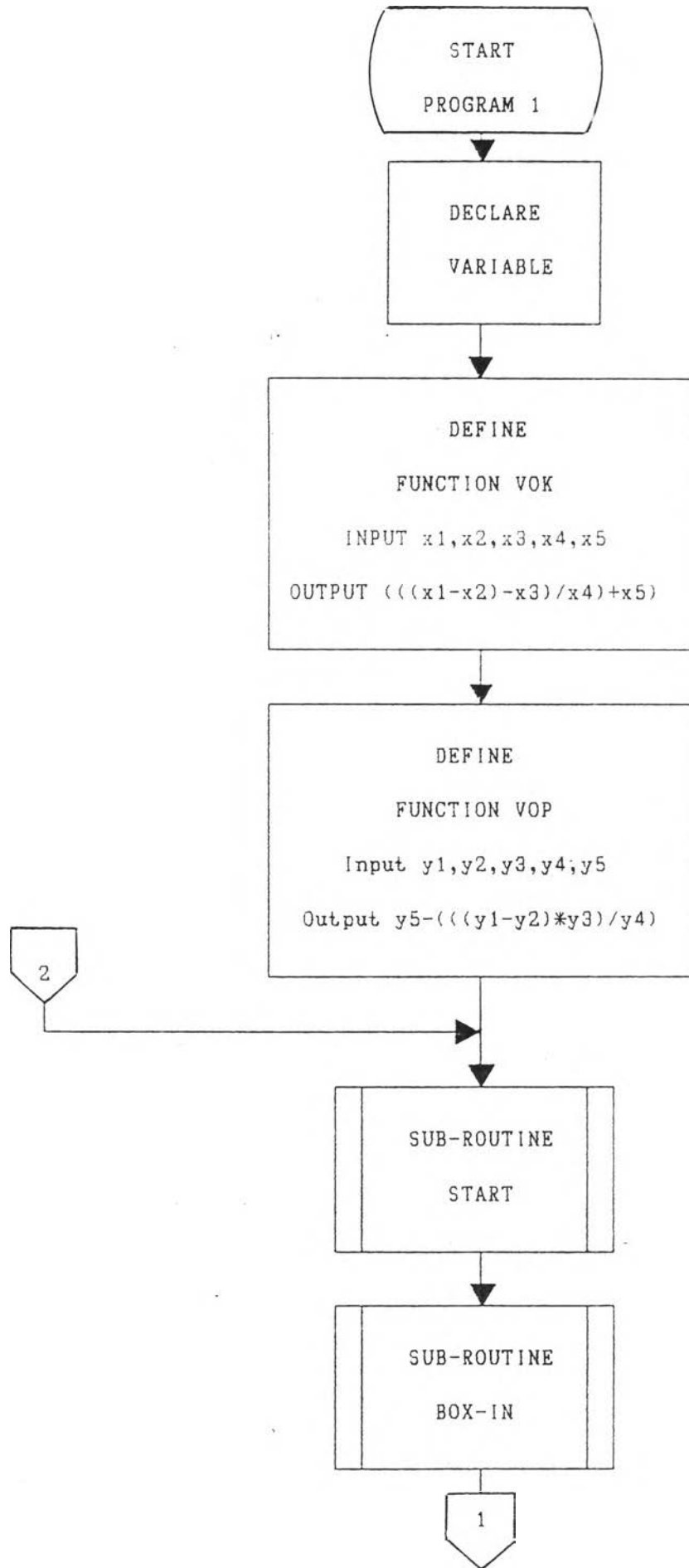
20. Annon, " Plate Heat Exchangers ", Power, 120(7), 35-37, 1976.
21. Sjorgen, S., W. Grueiro, " Applying Plate Exchangers in Hydrocarbon Processing ", Hydrocarbon Processing, 9, 133-136, 1983.
22. Bond, M.P., " Plate Heat Exchanger for Effective Heat Transfer ", The Chem. Engr., 4, 162-166, 1981.
23. Edwards, M.F., A.A. Changal, and D.L. Parrott, " Heat Transfer and Pressure Drop Characteristics of a Plate Heat Exchanger Using Newtonian and Non-Newtonian Liquid ", The Chem. Engr., 5, 286-288, 1974.
24. Harper, W.J., and C.W. Hall, Dairy Technology and engineering, Westport the Avi Pub., U.S.A., 1976.
25. Perry, J.H., Chemical Engineers' Handbook, 4th ed.. McGraw-Hill, 1963.
26. Edward, W.W., International Critical Tables of Numerical Data Physical Chemical and Technology, Vol. 5, McGraw-Hill, 1929.
27. Kessler, H. G., Food Engineering and Dairy Technology, Verlag A. Kessler Pub., Germany, 1981.
28. Hugot, E., Sugar series 7 handbook of cane sugar engineering, 3rd ed., pp. 449, Elsevier Science Pub., Amsterdam, 1986.

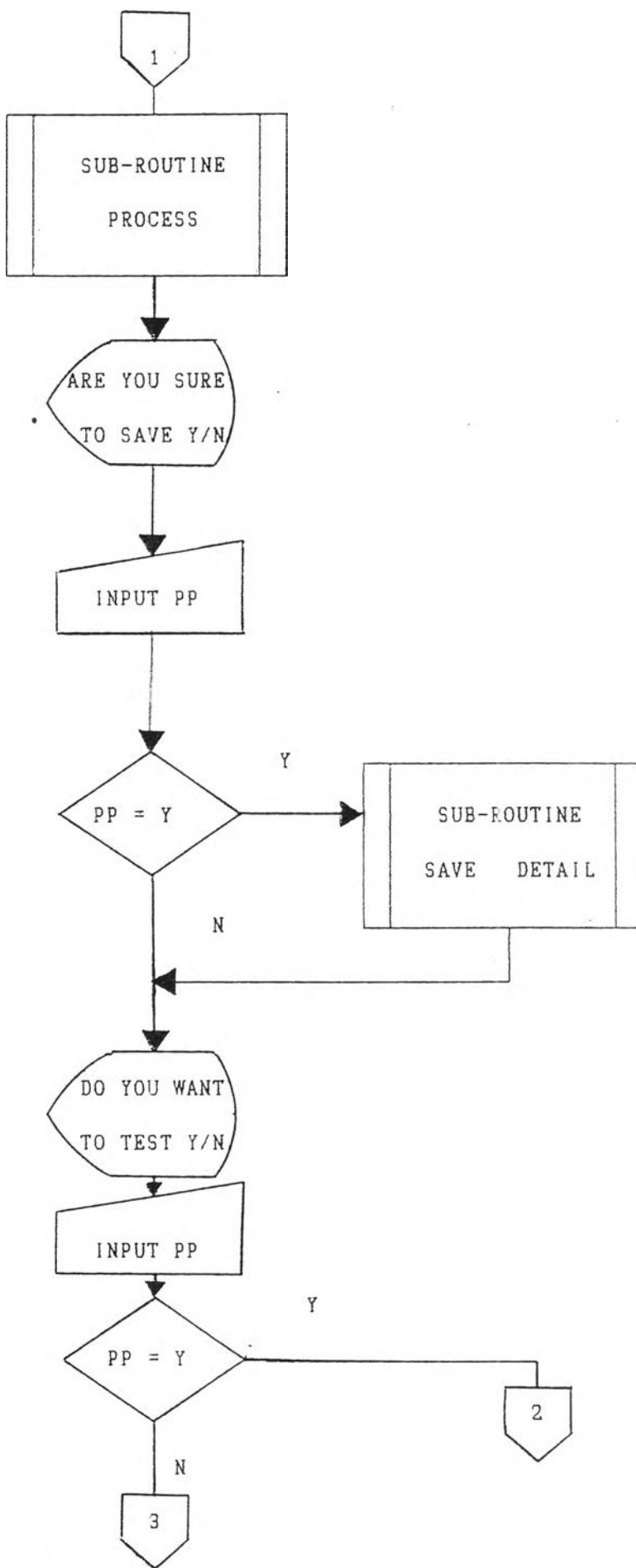
APPENDIX

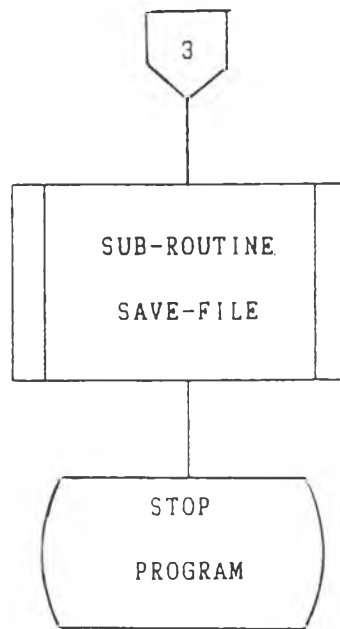


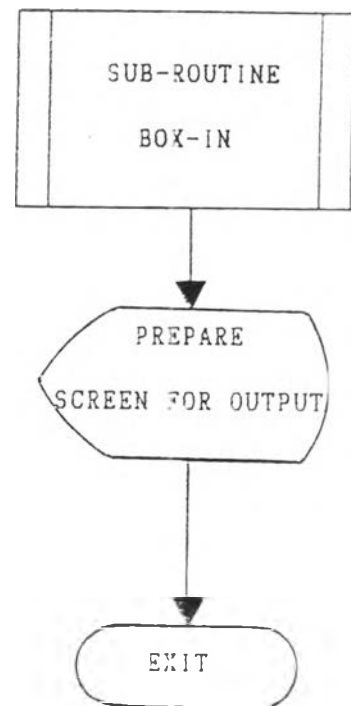
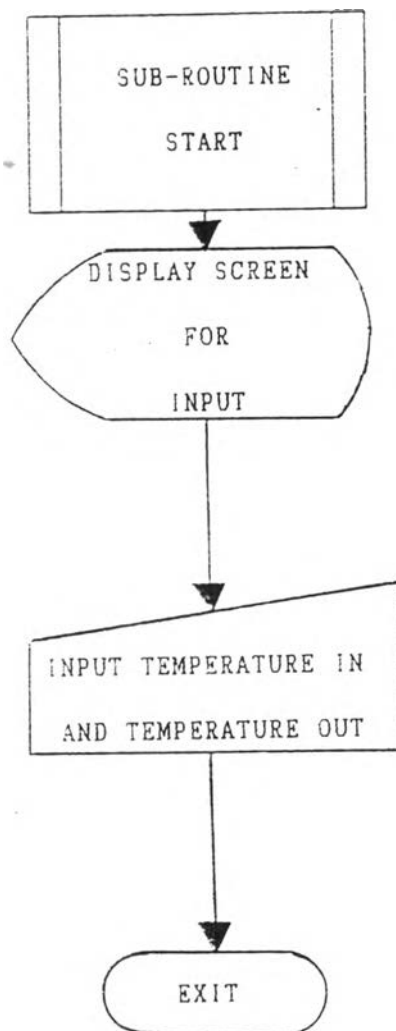
APPENDIX A

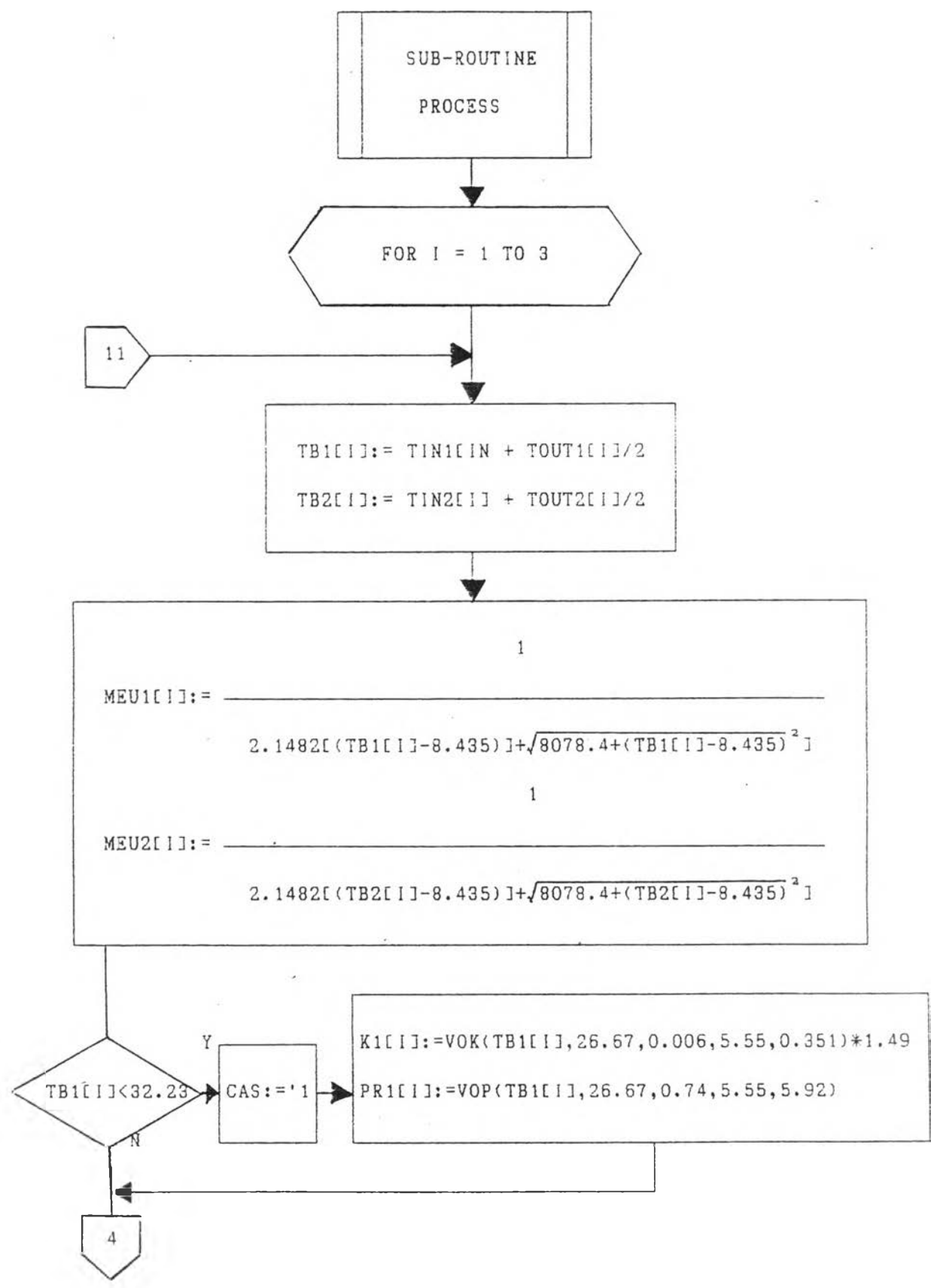
Appendix A shows the listing of all the programs used in this study and the flow charts of program 1 and program 2. The flow charts of program 3, 4, and 5 are similar to that of program 1, so they are omitted here.

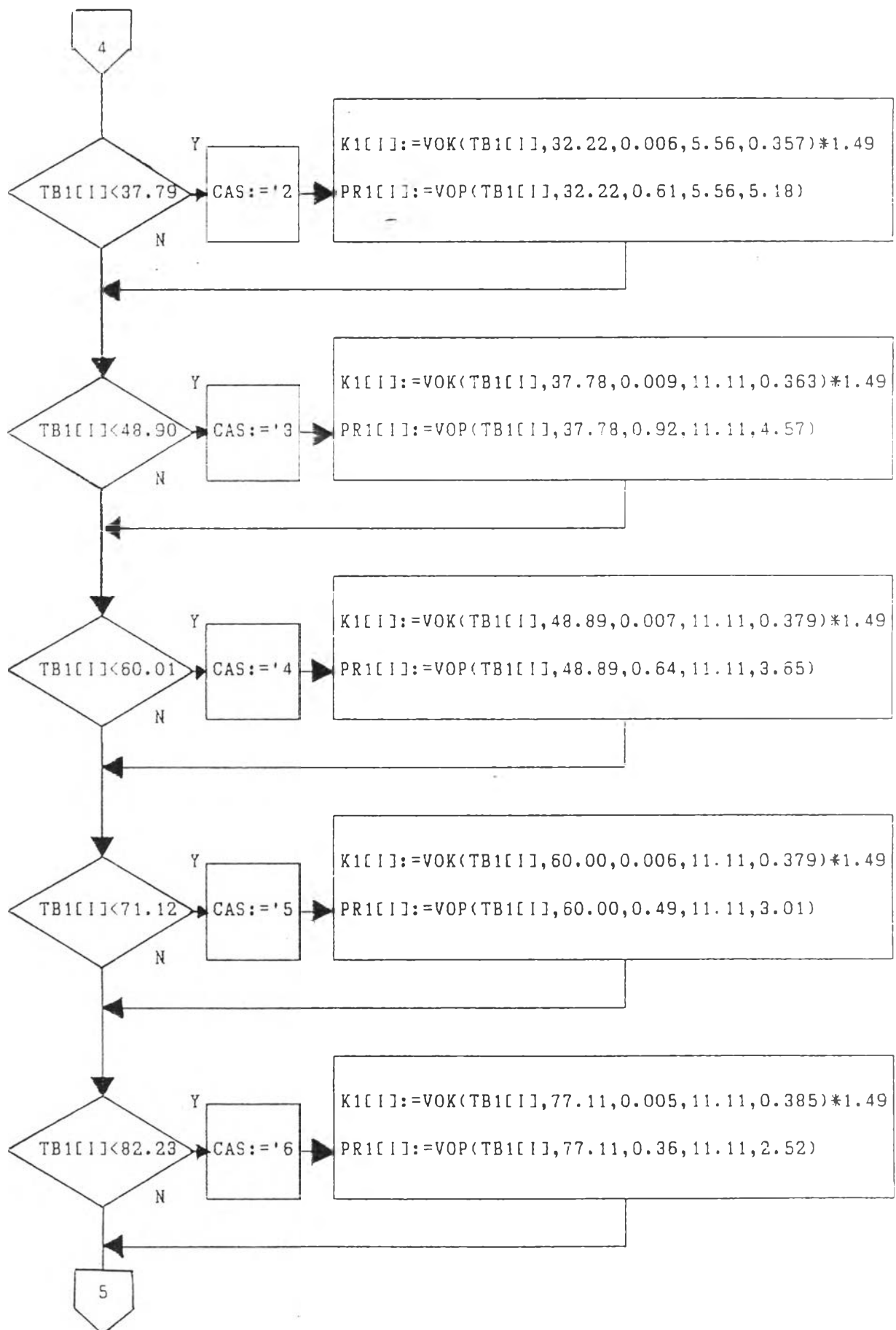


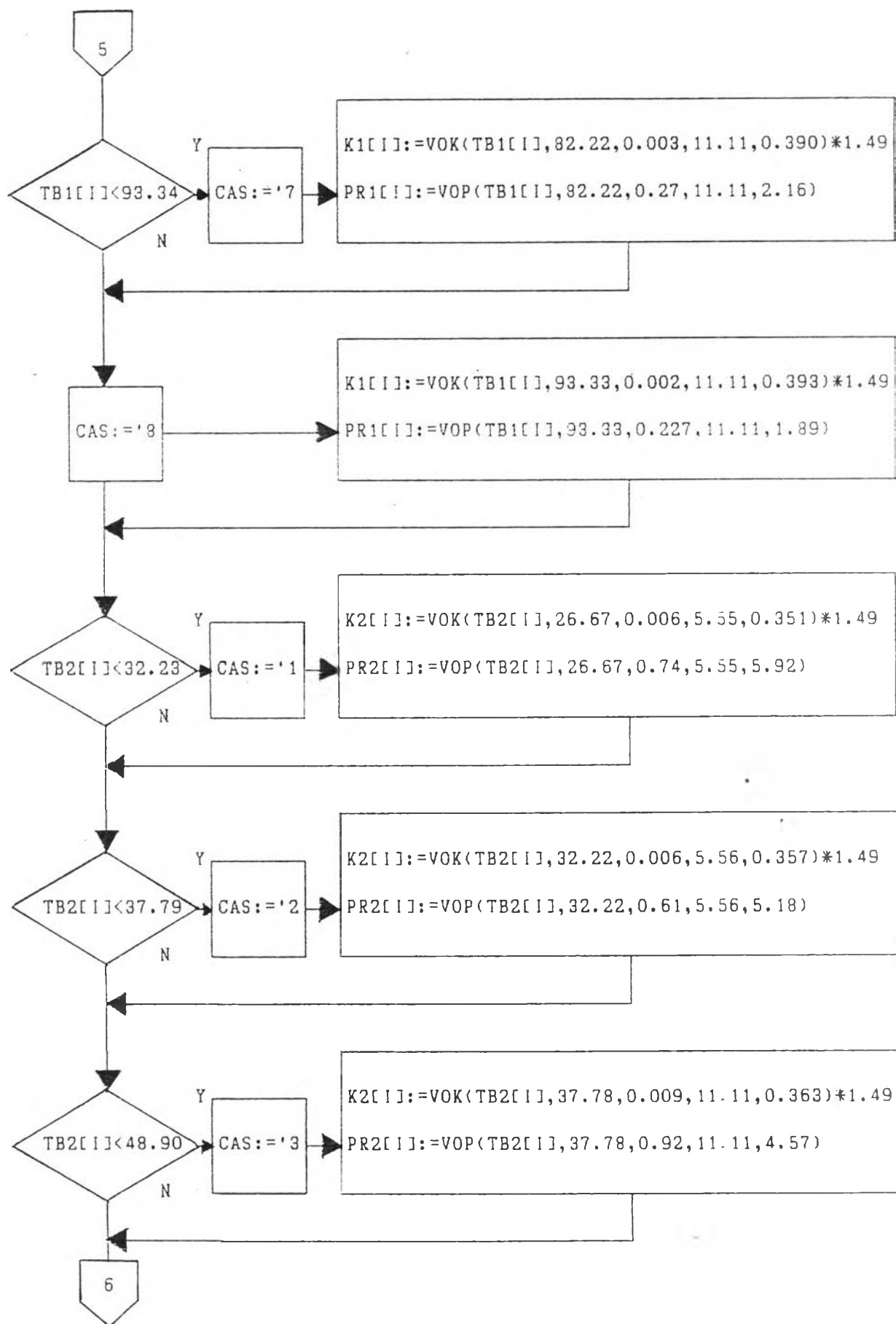


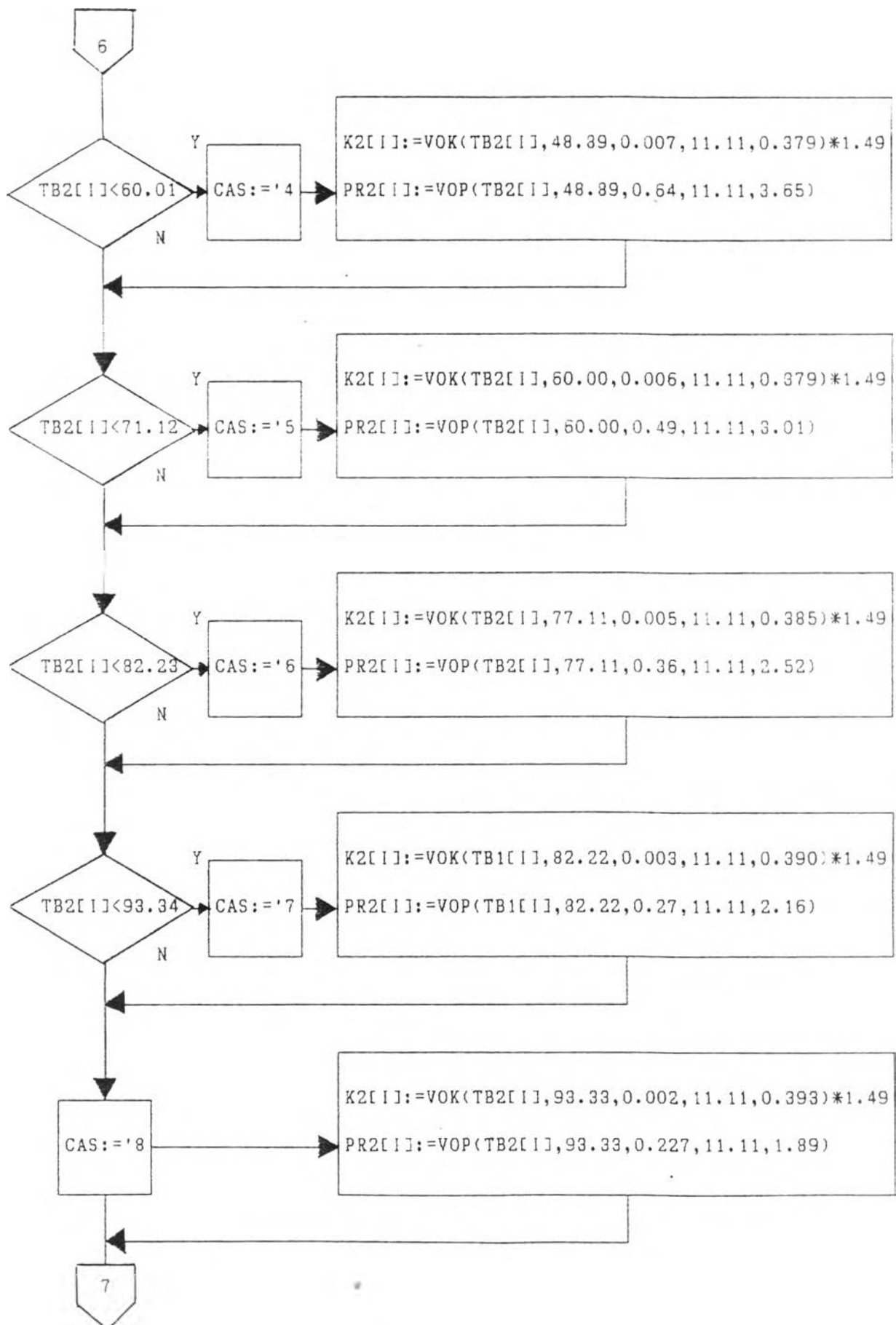


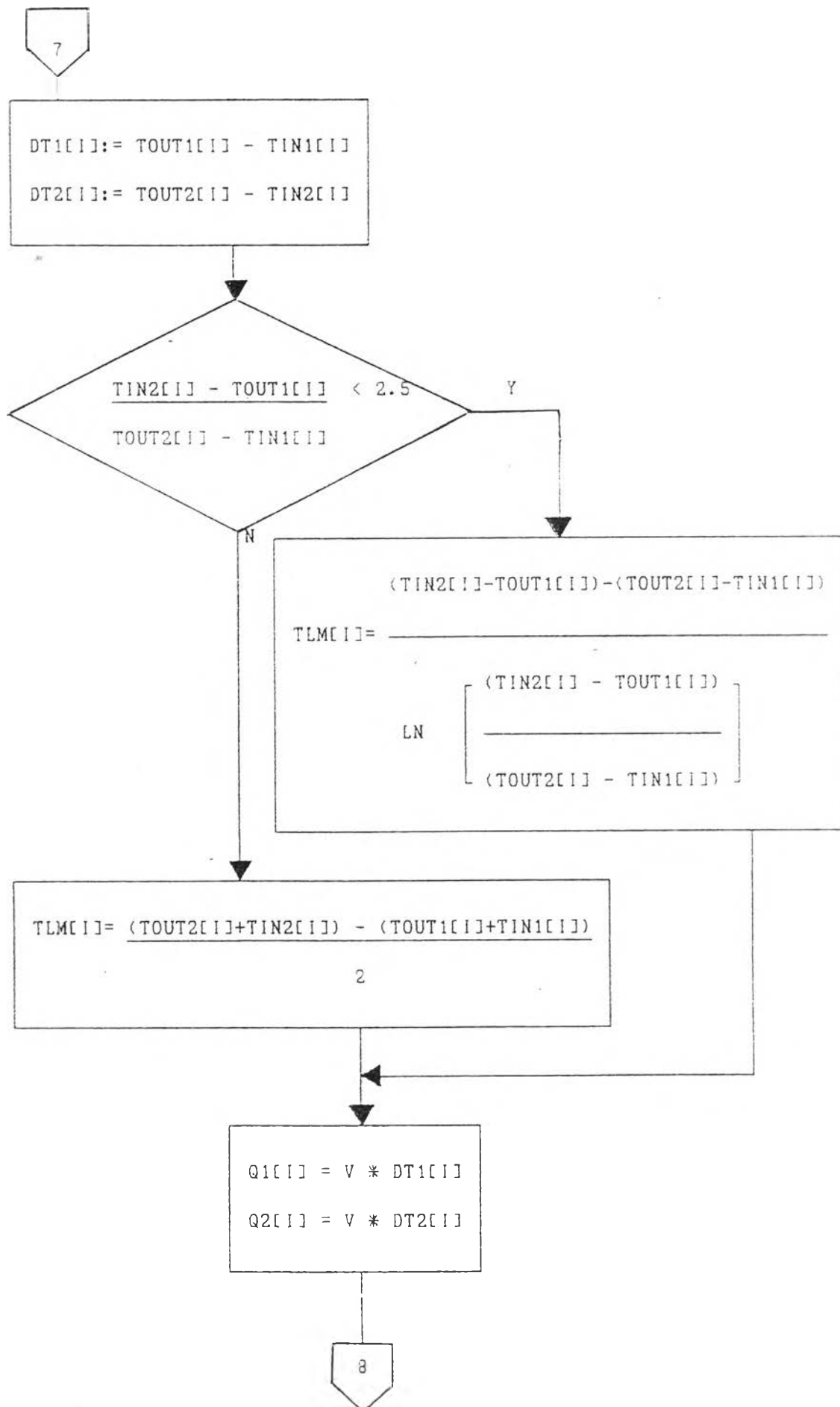


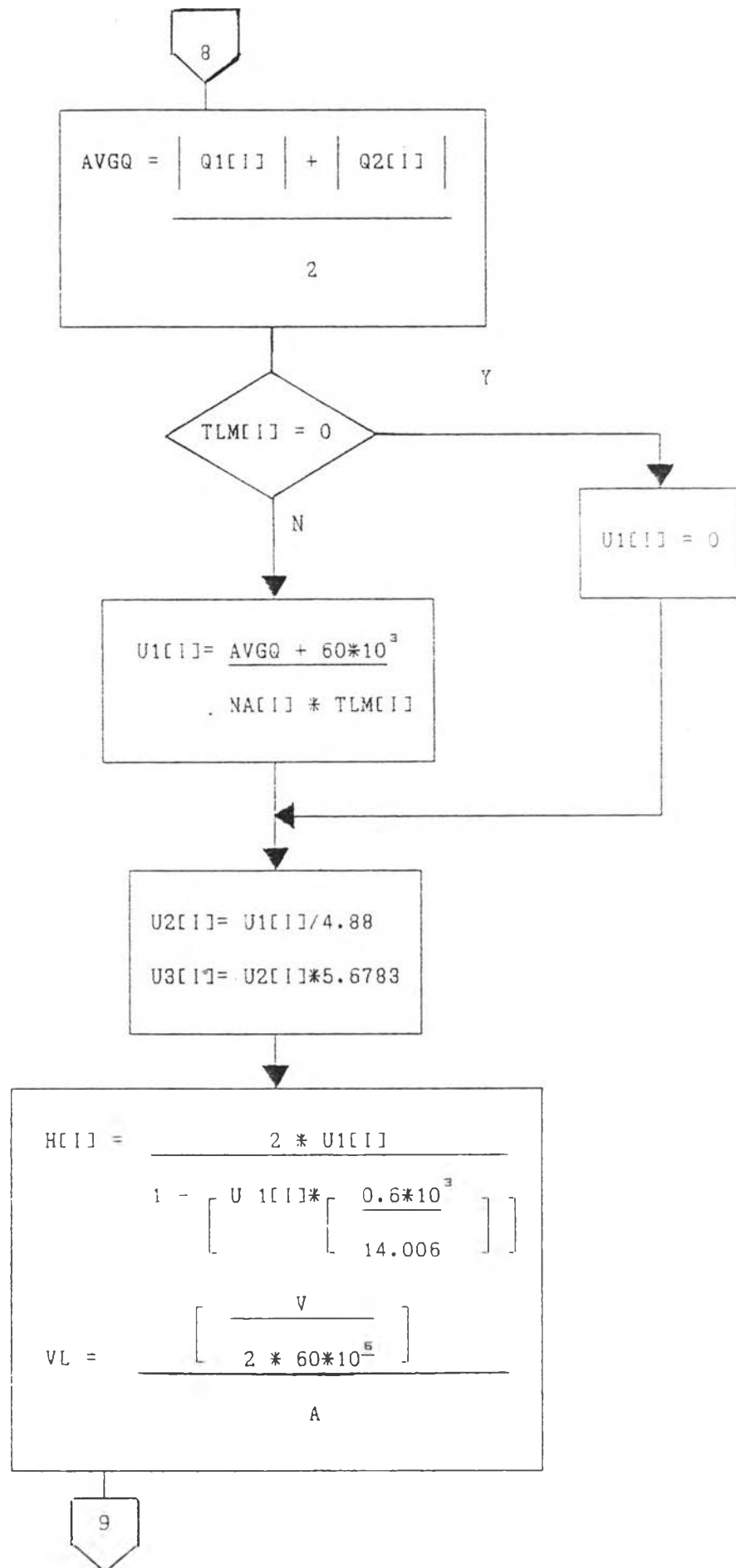


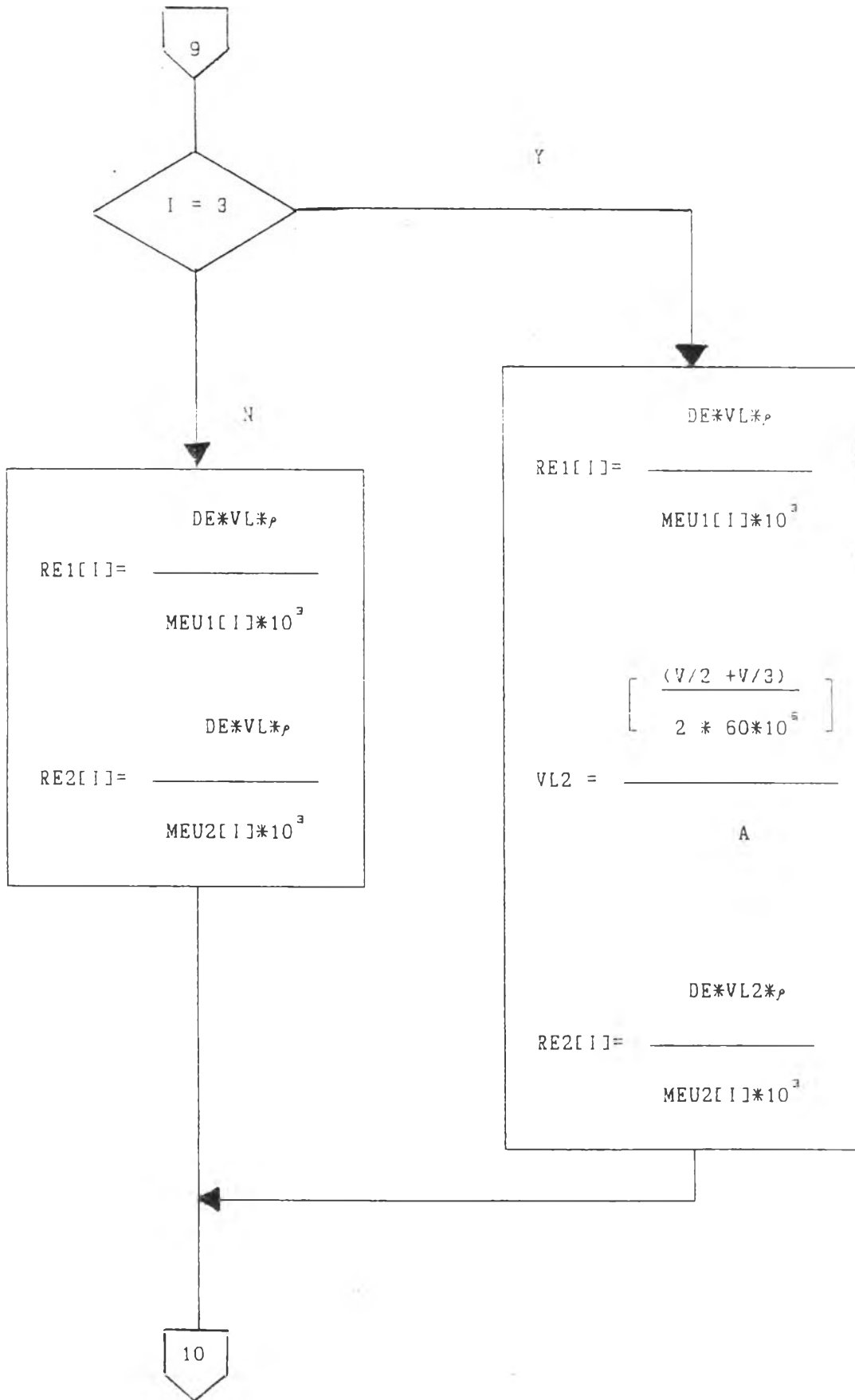












10

$$RC[I] = (RE1[I] + RE2[I]) / 2$$

$$HC1[I] = (K1[I] / DE) * (0.2 * RE1[I]^{0.67} * PR1[I]^{0.4})$$

$$HC2[I] = (K2[I] / DE) * (0.2 * RE2[I]^{0.67} * PR2[I]^{0.4})$$

$$HC[I] = (HC1[I] + HC2[I]) / 2$$

1

$$UC[I] = \frac{1}{\left[\frac{1}{HC1[I]} + \frac{0.6 * 10^3}{14.006} + \frac{1}{HC2[I]} \right]}$$

$$UC[I] = UC[I] / 4.88$$

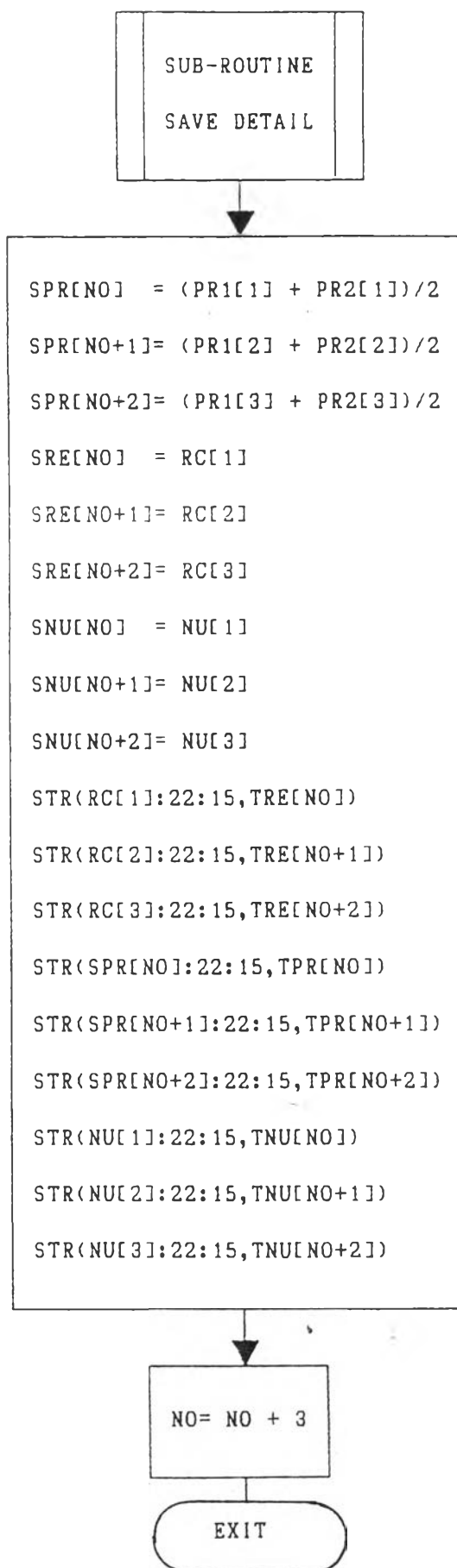
$$UC[I] = UC[I] * 5.6783$$

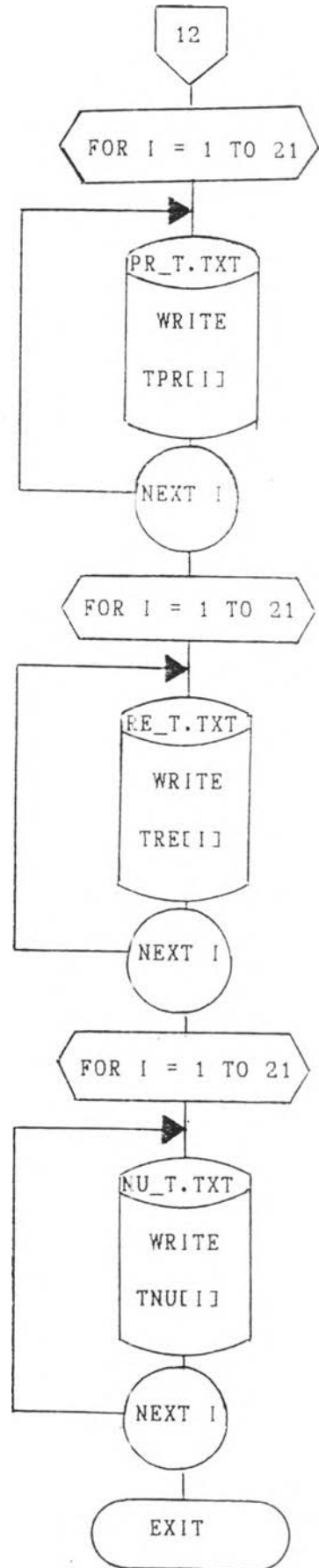
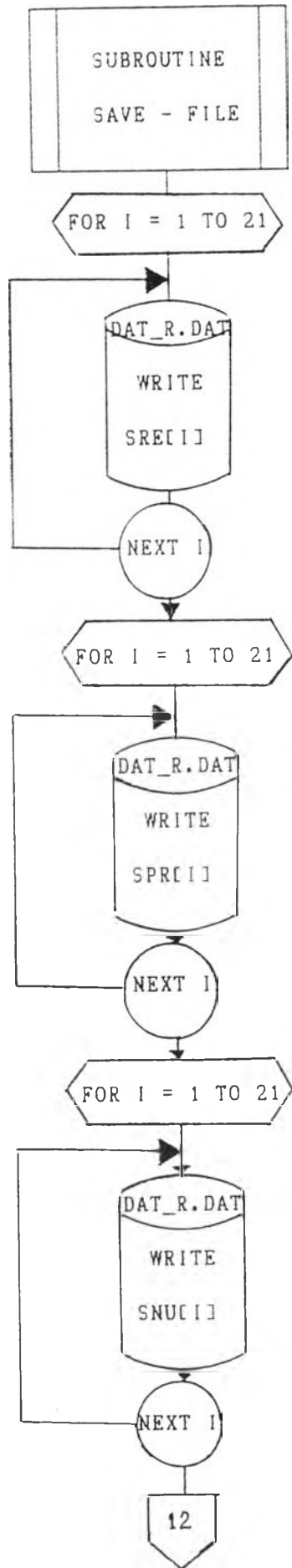
$$NU[I] = \frac{HC[I] * DE}{(K1[I] + K2[I]) / 2}$$

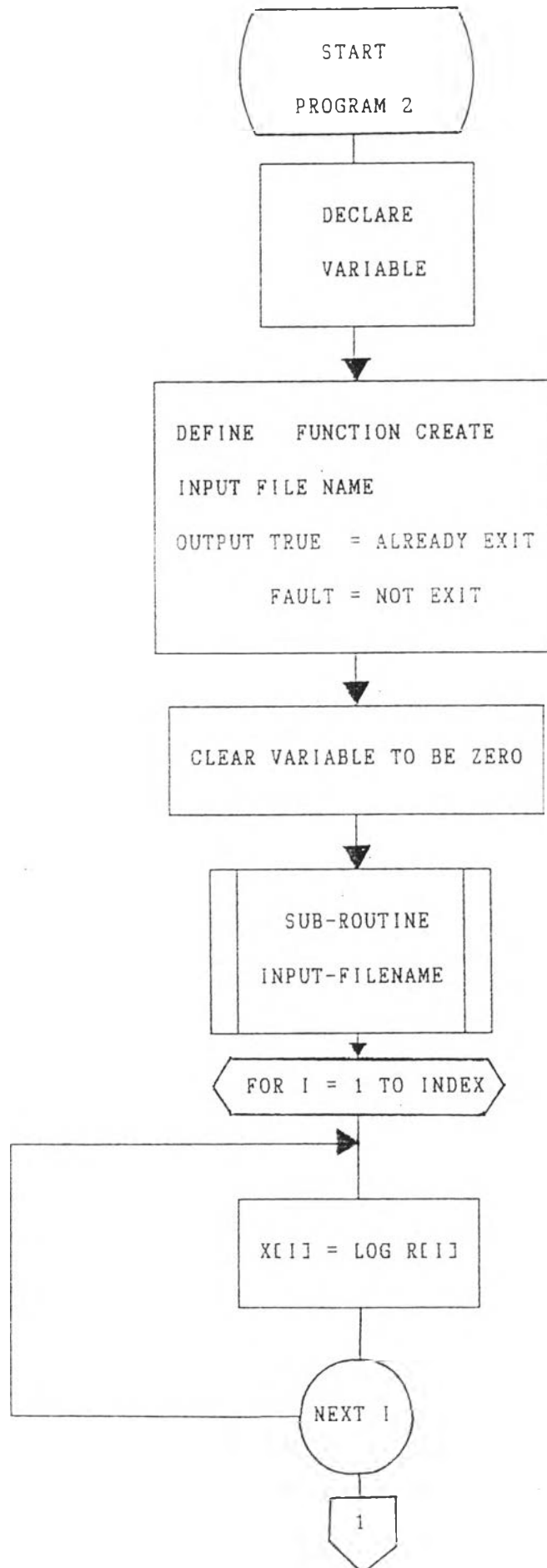
$$NUC[I] = \frac{HC[I] * DE}{(K1[I] + K2[I]) / 2}$$

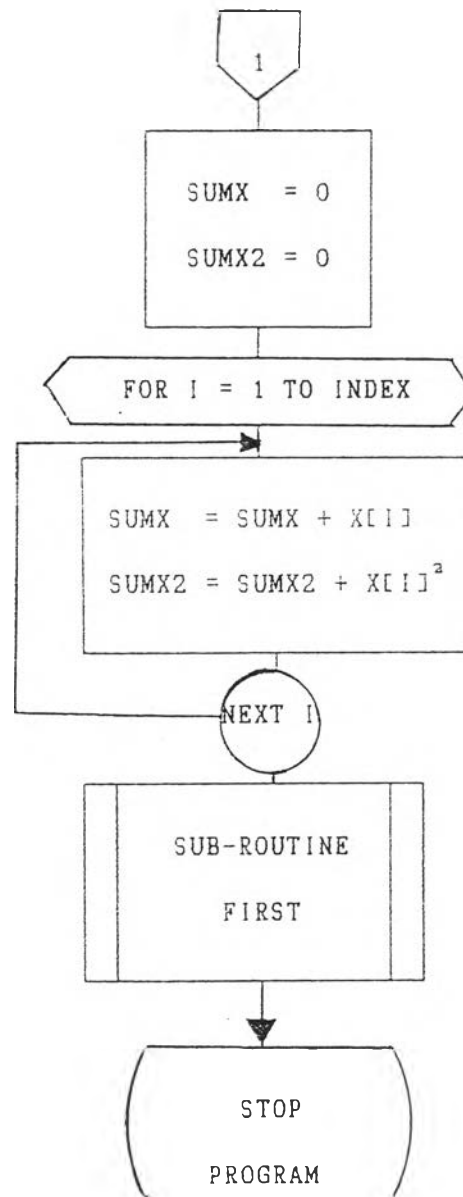
NEXT I

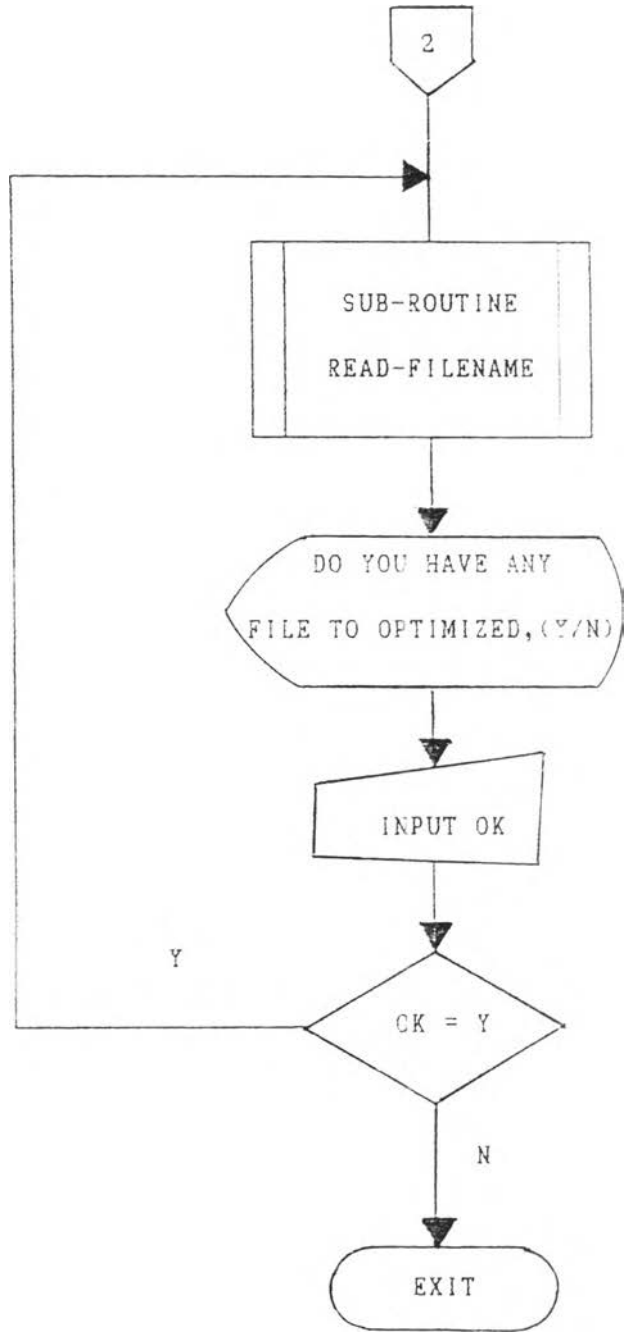
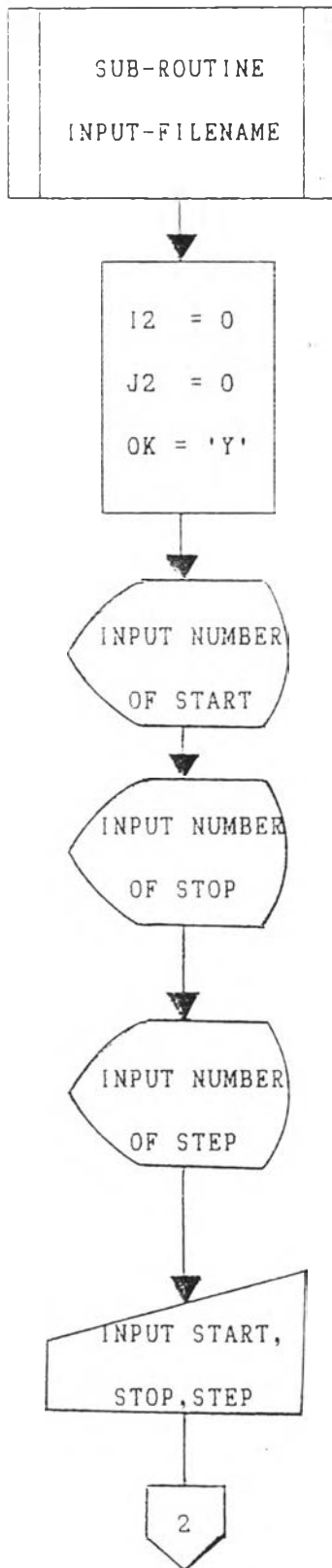
11

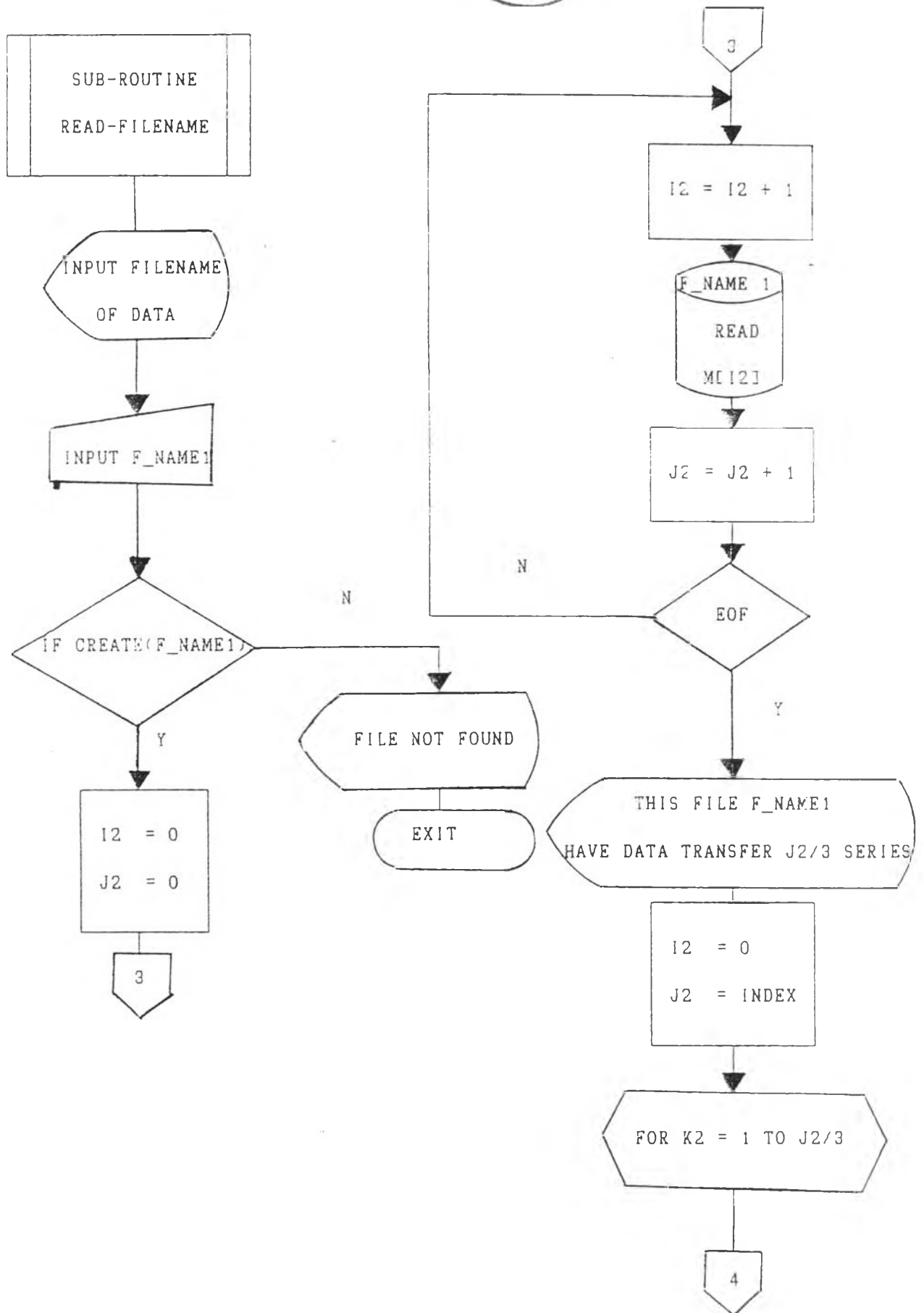


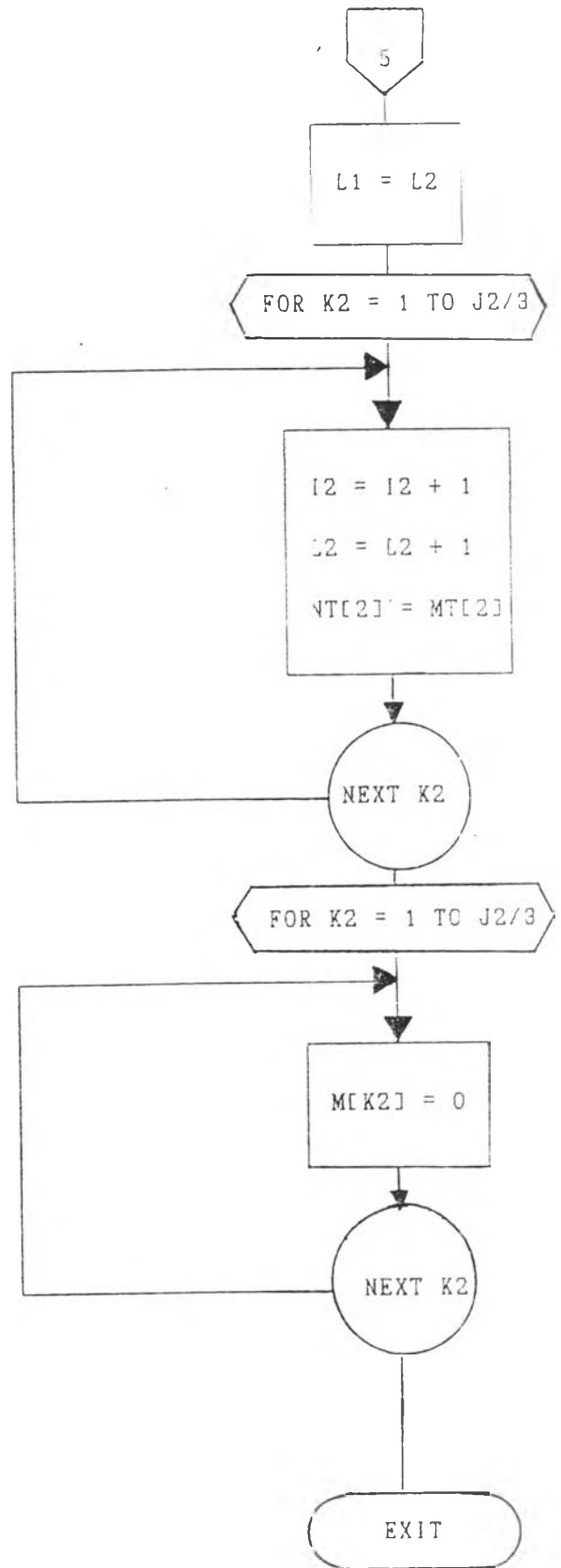
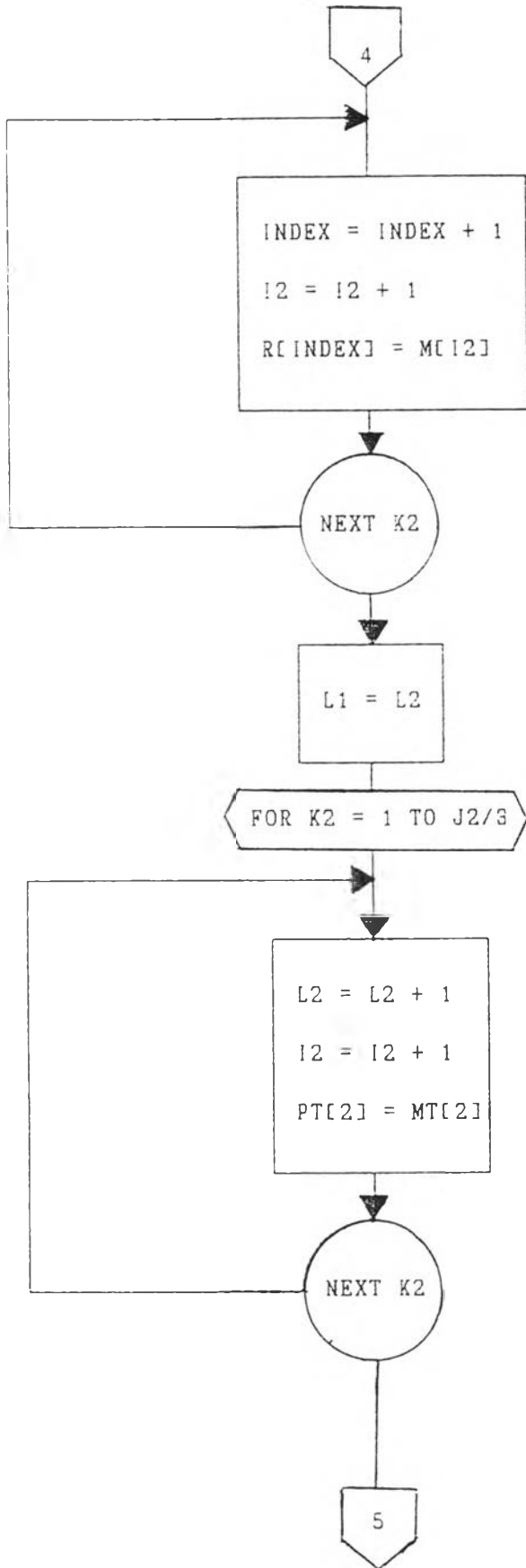


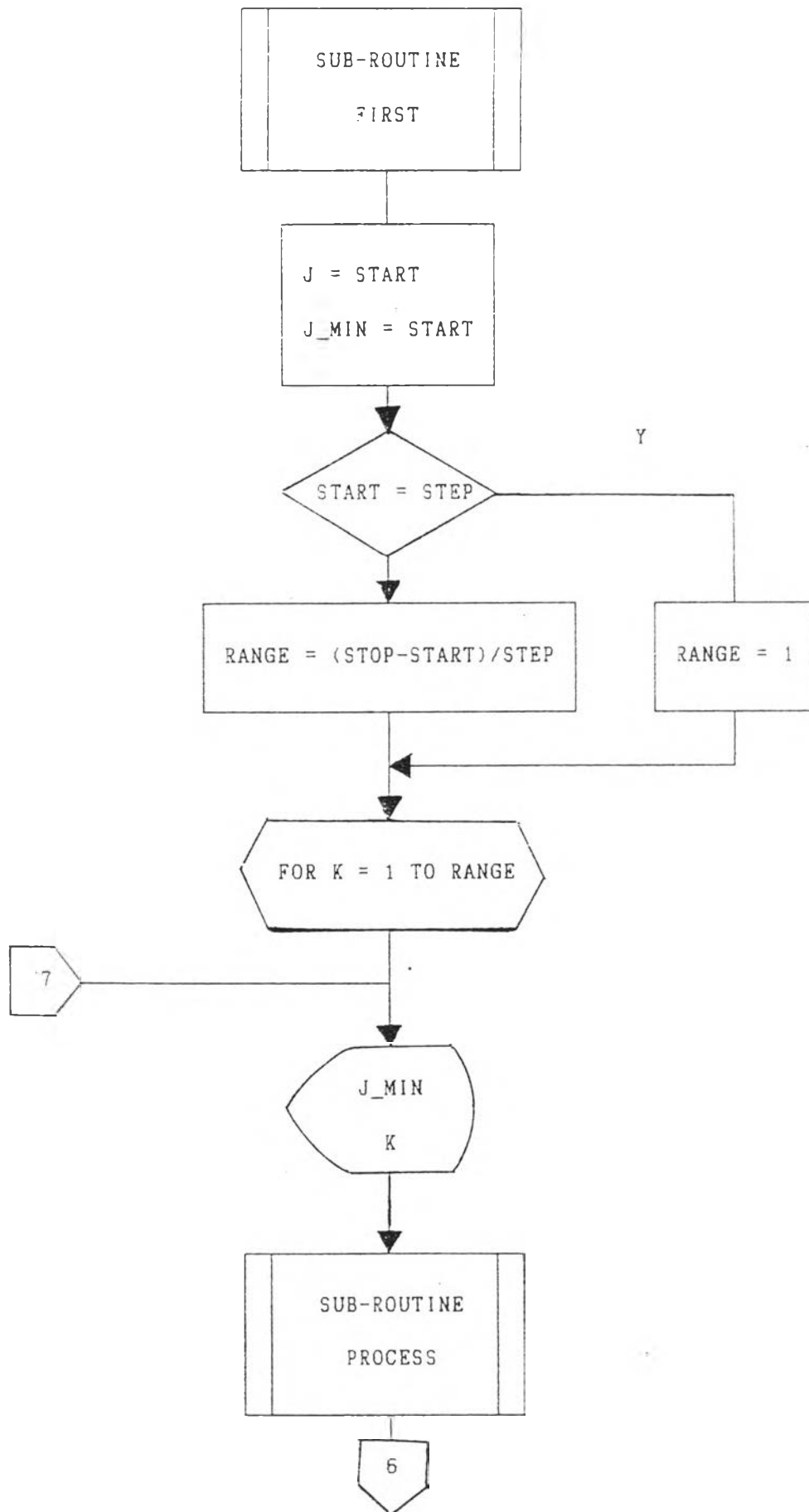


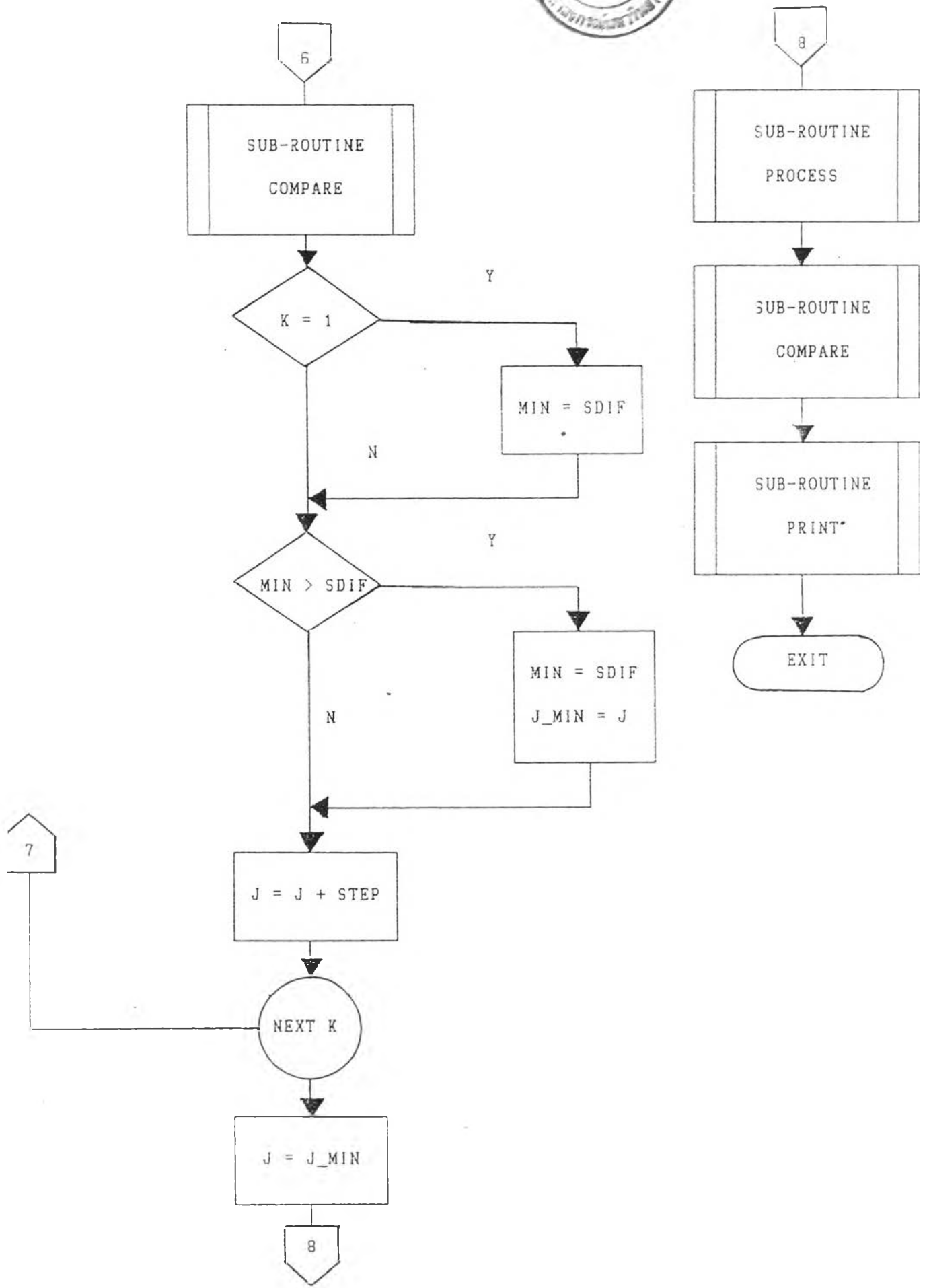


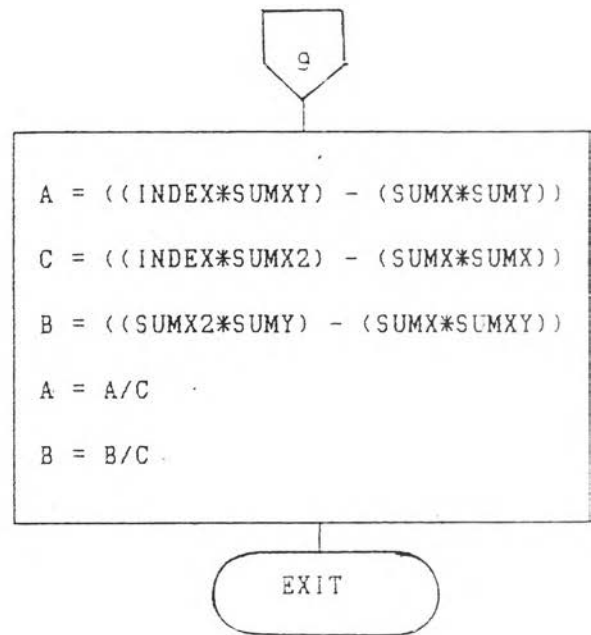
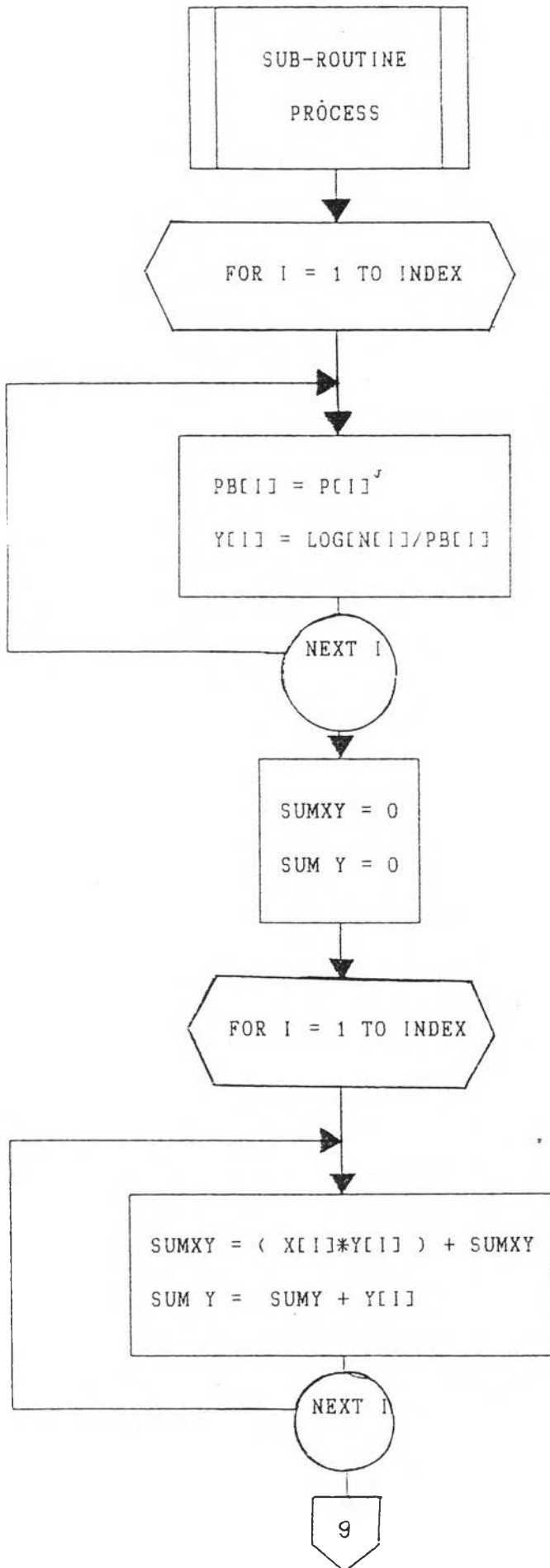


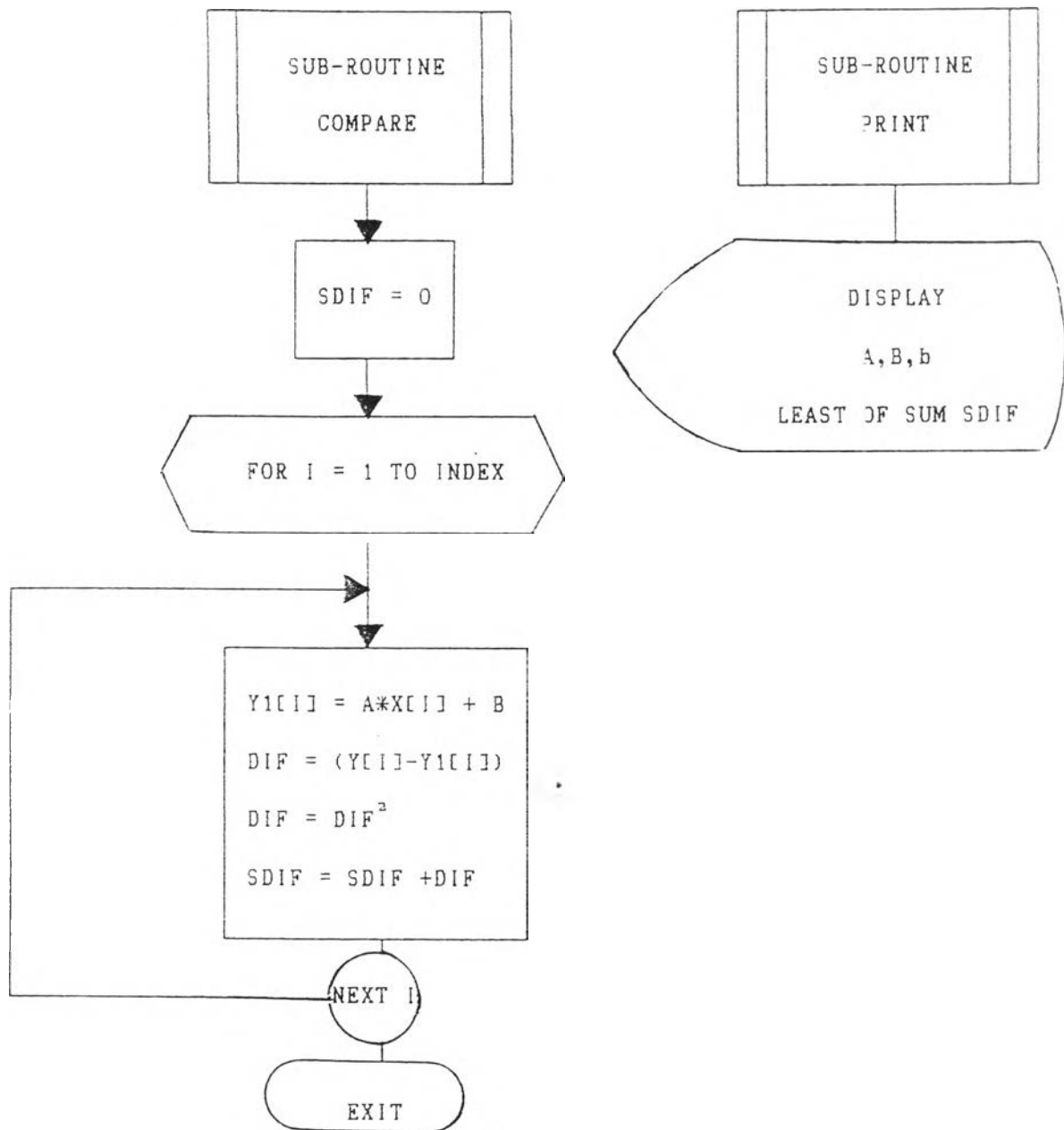












```

PROGRAM 1
TYPE FIVARR = FILE OF REAL,
FIVART = TEXT;
VAR F, H, HC, HC1, HC2, HA, RC, TIN, O1, O2, O3, OC, OC2 : ARRAY[1..3] OF REAL;
X1, X2, MEU1, MEU2, NO, NDC, PR1, PR2, Q1, Q2, RE1, RE2, T1, T2 : ARRAY[1..3] OF REAL;
DT1, DT2, TIN1, TIN2, TOUT1, TOUT2, DP, DP2, S, TR, TR1, TR2 : ARRAY[1..3] OF REAL;
AVGQ, DE, AA, A, P, L, V, V1, V2, VL, VL2, XJ, XJ : REAL;
SPP, SNO, SRE : ARRAY[1..21] OF REAL;
TRE, TPR, TNO : ARRAY[1..21] OF STRING(22);
I, J, RES, NO : INTEGER;
LINE55 : STRING(20);
PP, CAS, P1 : CHAR;
KK : STRING(2);
RR : FIVARR;
P_T, N_T, R_T : FIVART;
FUNCTION VOK(X1, X2, X3, X4, X5: REAL): REAL;
BEGIN
VOK := ((X1-X2)*X3)/X4+X5;
END;
FUNCTION VOP(Y1, Y2, Y3, Y4, Y5: REAL): REAL;
BEGIN
VOP := Y5 - ((Y1-Y2)*Y3)/Y4;
END;
PROCEDURE START;
BEGIN
CLRSCR;
GOTOXY(15, 3);
WRITE('THE VALUE OF V = ');
READLN (V);
GOTOXY(17, 5);
WRITE(LINE55);
GOTOXY(24, 6); WRITE('Tin');
GOTOXY(31, 6); WRITE('Tout');
GOTOXY(17, 7); WRITE(LINE55);
GOTOXY(20, 8); WRITE('1');
GOTOXY(17, 9); WRITE('3');
GOTOXY(20, 10); WRITE('2');
GOTOXY(17, 11); WRITE(LINE55);
GOTOXY(20, 12); WRITE('1');
GOTOXY(17, 13); WRITE('1');
GOTOXY(20, 14); WRITE('2');
GOTOXY(17, 15); WRITE(LINE55);
GOTOXY(20, 16); WRITE('1');
GOTOXY(17, 17); WRITE('2');
GOTOXY(20, 18); WRITE('2');
GOTOXY(17, 19); WRITE(LINE55);
FOR I = 1 TO 3 DO
BEGIN
GOTOXY(24, (I*2)+I*2+4); READLN(TIN1[I]);
GOTOXY(24, (I*2)+I*2+6); READLN(TIN2[I]);
END;
FOR I = 1 TO 3 DO
BEGIN
GOTOXY(31, (I*2)+I*2+4); READLN(TOUT1[I]);
GOTOXY(31, (I*2)+I*2+6); READLN(TOUT2[I]);
END;
END;
PROCEDURE PROCESS;
BEGIN

```

```

FOR I:= 1 TO 30
  BEGIN
    BEGIN
      TB1[I]:= (TIN1[I] + TOUT1[I]) / 2;
      TB2[I]:= (TIN2[I] + TOUT2[I]) / 2;
    END;
    BEGIN
      #EU1[I]:= (1/(2.1482*((TB1[I]-8.435)+SQRT(8078.4+((TB1[I]-8.435)*(TB1[I]-8.435))))-120))*100;
      #EU2[I]:= (1/(2.1482*((TB2[I]-8.435)+SQRT(8078.4+((TB2[I]-8.435)*(TB2[I]-8.435))))-120))*100;
    END;
  END;
  BEGIN
    IF TB1[I] < 32.23 THEN
      CAS:= '1'
    ELSE
      IF TB1[I] < 37.79 THEN
        CAS:= '2'
      ELSE
        IF TB1[I] < 48.9 THEN
          CAS:= '3'
        ELSE
          IF TB1[I] < 60.01 THEN
            CAS:= '4'
          ELSE
            IF TB1[I] < 71.12 THEN
              CAS:= '5'
            ELSE
              IF TB1[I] < 82.23 THEN
                CAS:= '6'
              ELSE
                IF TB1[I] < 93.34 THEN
                  CAS:= '7'
                ELSE
                  CAS:= '8';
                END;
            END;
          END;
        END;
      END;
    END;
  CASE CAS OF
    '1' : BEGIN
      K1[I]:= VOK(TB1[I],26.67,0.006,5.55,0.351)*1.49;
      PR1[I]:=VOP(TB1[I],26.67,0.74,5.55,3.92);
    END;
    '2' : BEGIN
      K1[I]:= VOK(TB1[I],32.22,0.006,5.56,0.357)*1.49;
      PR1[I]:=VOP(TB1[I],32.22,0.61,5.56,5.18);
    END;
    '3' : BEGIN
      K1[I]:= VOK(TB1[I],37.78,0.009,11.11,0.363)*1.49;
      PR1[I]:=VOP(TB1[I],37.78,0.92,11.11,4.57);
    END;
    '4' : BEGIN
      K1[I]:= VOK(TB1[I],48.89,0.007,11.11,0.372)*1.49;
      PR1[I]:=VOP(TB1[I],48.89,0.64,11.11,3.65);
    END;
    '5' : BEGIN
      K1[I]:= VOK(TB1[I],60.0,0.006,11.11,0.379)*1.49;
      PR1[I]:=VOP(TB1[I],60.0,0.49,11.11,3.01);
    END;
    '6' : BEGIN
      K1[I]:= VOK(TB1[I],71.11,0.005,11.11,0.385)*1.49;
      PR1[I]:=VOP(TB1[I],71.11,0.36,11.11,2.52);
    END;
    '7' : BEGIN

```

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      K1[I]:= VOK(TB1[I], 32.22, 0.002, 11.11, 0.390)*1.49;
      PR1[I]:=VOP(TB1[I], 32.22, 0.27, 11.11, 2.16);
    END;
  '3' : BEGIN
      K1[I]:= VOK(TB1[I], 93.33, 0.002, 11.11, 0.393)*1.49;
      PR1[I]:=VOP(TB1[I], 93.33, 0.227, 11.11, 1.99);
    END;
  END;
END;
BEGIN
  IF TB2[I] < 32.23 THEN
    CAS:= '1'
  ELSE
    IF TB2[I] < 37.79 THEN
      CAS:= '2'
    ELSE
      IF TB2[I] < 48.9 THEN
        CAS:= '3'
      ELSE
        IF TB2[I] < 60.01 THEN
          CAS:= '4'
        ELSE
          IF TB2[I] < 71.12 THEN
            CAS:= '5'
          ELSE
            IF TB2[I] < 82.23 THEN
              CAS:= '6'
            ELSE
              IF TB2[I] < 93.34 THEN
                CAS:= '7'
              ELSE
                CAS:= '8';
      CASE CAS OF
        '1' : BEGIN
            K2[I]:= VOK(TB2[I], 26.67, 0.006, 5.55, 0.351)*1.49;
            PR2[I]:=VOP(TB2[I], 26.67, 0.74, 5.55, 5.92);
          END;
        '2' : BEGIN
            K2[I]:= VOK(TB2[I], 32.22, 0.006, 5.56, 0.357)*1.49;
            PR2[I]:=VOP(TB2[I], 32.22, 0.61, 5.56, 5.18);
          END;
        '3' : BEGIN
            K2[I]:= VOK(TB2[I], 37.78, 0.009, 11.11, 0.363)*1.49;
            PR2[I]:=VOP(TB2[I], 37.78, 0.92, 11.11, 4.57);
          END;
        '4' : BEGIN
            K2[I]:= VOK(TB2[I], 48.89, 0.007, 11.11, 0.372)*1.49;
            PR2[I]:=VOP(TB2[I], 48.89, 0.64, 11.11, 3.65);
          END;
        '5' : BEGIN
            K2[I]:= VOK(TB2[I], 60.0, 0.006, 11.11, 0.379)*1.49;
            PR2[I]:=VOP(TB2[I], 60.0, 0.49, 11.11, 3.01);
          END;
        '6' : BEGIN
            K2[I]:= VOK(TB2[I], 71.11, 0.005, 11.11, 0.385)*1.49;
            PR2[I]:=VOP(TB2[I], 71.11, 0.36, 11.11, 2.52);
          END;
        '7' : BEGIN
            K2[I]:= VOK(TB2[I], 82.22, 0.003, 11.11, 0.390)*1.49;
            PR2[I]:=VOP(TB2[I], 82.22, 0.27, 11.11, 2.16);

```

```

END;
'3' : BEGIN
      K2[I]:= VOK(TB2[I],93.33,0.002,11.11,0.393)*1.49;
      PR2[I]:=VOP(TB2[I],93.33,0.227,11.11,1.39);
      END;
END;
END;
DT1[I]:= TOUT1[I] - TIN1[I];
DT2[I]:= TOUT2[I] - TIN2[I];
IF (TIN2[I]-TOUT1[I])/(TOUT2[I]-TIN1[I]) < 2.5 THEN
TIM[I]:= ((TOUT2[I] + TIN2[I]) - (TOUT1[I] + TIN1[I]))/2
ELSE
TIM[I]:= ((TIN2[I]-TOUT1[I])-(TOUT2[I]-TIN1[I]))/LN((TIN2[I]-TOUT1[I])/(TOUT2[I]-TIN1[I]));
Q1[I]:= V * DT1[I];
Q2[I]:= V * DT2[I];
AVGQ:=( ABS(Q1[I]) + ABS(Q2[I]) )/2;
IF TIM[I] = 0 THEN
  U1[I]:= 0
ELSE
  U1[I]:= (AVGQ*60* 0.001)/(NA[I]* TIM[I]);
U2[I]:= U1[I] / 4.38;
U3[I]:= U2[I] * 5.6783;
B[I]:= (2*U1[I])/((1-(U1[I]*((0.6*0.001))/14.006)));
VL := (V/(2*60*1.0E+06))/A;
IF I=3 THEN
  BEGIN
    RE1[I] := (DE*VL*P)/(MEU1[I]*0.001);
    TR1[I] := (2*U1[I]*AA)/((V/2)*60*0.001);
    VL2 := ((V/2+V/3)/(2*60*1.0E+06))/A;
    RE2[I]:= (DE*VL2*P)/(MEU2[I]*0.001);
    TR2[I]:= (2*U1[I]*AA)/(((V/2+V/3)/2)*60*0.001);
    TR[I]:= ( TR1[I] +TR2[I] )/2;
  END
ELSE
  BEGIN
    RE1[I] := (DE*VL*P)/(MEU1[I]*0.001);
    RE2[I] := (DE*VL*P)/(MEU2[I]*0.001);
    TR[I]:= (2*U1[I]*AA)/((V/2)*60*0.001);
  END;
RC[I]:= (RE1[I] + RE2[I])/2;
HC1[I] := (0.2*EXP(0.67*LN(RE1[I]))*EXP(0.4*LN(PR1[I])) * K1[I])/DE;
HC2[I] := (0.2*EXP(0.67*LN(RE2[I]))*EXP(0.4*LN(PR2[I])) * K2[I])/DE;
HC[I] := ( HC1[I] + HC2[I] )/2;
UC[I] := 1 / ((1/HC[I]) + ((0.6*0.001)/14.006) + ( 1/HC2[I]));
OC[I] := UC[I]/4.38;
UC[I] := UC[I]*5.6783;
F[I]:= 1.22/ ( EXP(0.252*LN(RC[I])));
IF I = 3 THEN
  DP[I] := ((2*F[I]*L*(((V*0.001/2+V*0.001/3)/120)/A)*(((V*0.001/2+V*0.001/3)/120)/A))/((DE*P))*0.001
ELSE
  DP[I] := ((2*F[I]*L*(((V*0.001/(2*60))/A)*((V*0.001/(2*60))/A)))/((DE*P))*0.001;
DP2[I] :=DP[I] /(6.3948*1.4599738);
NU[I]:= H[I] *DE/((K1[I]+K2[I])/2);
NOC[I]:= HC[I]*DE/((K1[I]+K2[I])/2);
END;
END;
END;
PROCEDURE SAVE_DETAIL;
BEGIN;
  SPR(NO):= (PR1[I]+PR2[I])/2;

```



```

SPR{NO}:= (PR1{1}+PR2{1})/2;
SPR{NO+1}:= (PR1{2}+PR2{2})/2;
SPR{NO+2}:= (PR1{3}+PR2{3})/2;
SRE{NO}:= RC{1};
SRE{NO+1}:=RC{2};
SRE{NO+2}:=RC{3};
SNU{NO}:=NU{1};
SNU{NO+1}:=NU{2};
SNU{NO+2}:=NU{3};
STR(RC{1}:22:15,TRF{NO});
STR(RC{2}:22:15,TRF{NO+1});
STR(RC{3}:22:15,TRF{NO+2});
STR(SPR{NO}:22:15,TPR{NO});
STR(SPR{NO+1}:22:15,TPR{NO+1});
STR(SPR{NO+2}:22:15,TPR{NO+2});
STR(NU{1}:22:15,TNU{NO});
STR(NU{2}:22:15,TNU{NO+1});
STR(NU{3}:22:15,TNU{NO+2});
NO:=NO+3;
END;
PROCEDURE SAVE_FILE;
BEGIN
  ASSIGN (RR, 'DAT_R.EAT');
  REWRITE(RR);
  FOR I:= 1 TO 21 DO
    WRITE(RR,SRE{I});
  FOR I:= 1 TO 21 DO
    WRITE(RR,SPR{I});
  FOR I:= 1 TO 21 DO
    WRITE(RR,SNU{I});
  CLOSE(RR);
  ASSIGN(R_T, 'PR_T.TXT');
  REWRITE(R_T);
  FOR I:= 1 TO 21 DO
    WRITELN(R_T,TPR{I});
  CLOSE(R_T);
  ASSIGN(P_T, 'RE_T.TXT');
  REWRITE(P_T);
  FOR I:=1 TO 21 DO
    WRITELN(P_T,TRF{I});
  CLOSE(P_T);
  ASSIGN(N_T, 'NU_T.TXT');
  REWRITE(N_T);
  FOR I:=1 TO 21 DO
    WRITELN(N_T,TNU{I});
  CLOSE(N_T);
END;
BEGIN{MAIN}
NA[1] := 0.55;
NA[2] := 1.75;
NA[3] := 0.4;
AA := 0.05;
DE := 6.26 * 0.001;
A := 11.25 * 0.0001 * 0.313;
P := 1000;
L := 44.5 * 0.01;
LINE55:= '-----';
NO:= 1;
BEGIN
  REPEAT
  BEGIN

```

```
START;
PROCESS;
GOTOXY(14,24); WRITE('ARE YOU SURE TO SAVE (Y/N)?');
READ(KBD,PP);
IF UPCASE(PP) = 'Y' THEN SAVE_DETAIL;
GOTOXY(14,24); WRITE('DO YOU WANT TO TEST (Y/N) ? ');
READ(KBD,PP);
END;
UNTIL UPCASE(PP) = 'N';
END;
SAVE_FILE;
END.
```

```

PROGRAM 2
TYPE
FIVARR      = FILE OF REAL;
VAR
  I2,J2,K2,L2,L1 : INTEGER;
  I,K,SCANCODE, N_DATA, INDEX,RANGE      : INTEGER;
  SUMXY, SUMX, SOMY, SUMX2,
  A, B, C, DIF, SDIF, J, MIN,
  J_MIN, START, STOP, STEP      : REAL;
  X,Y,Y1,R,N,PB,P                : ARRAY[1..500] OF REAL;
  M                                : ARRAY[1..500] OF REAL;
  PP,P1                            : CHAR;
  RR                                : FIVARR;
  F_NAME1, F_NAME2, F_NAME3      : STRING[14];
  OK                                : BOOLEAN;
FUNCTION CREATE(VAR SOMEFI : FIVARR) : BOOLEAN;
BEGIN
  {$I-} RESET(SOMEFI); {$I+}
  CREATE := IORESULT = 0;
END;
PROCEDURE PROCESS;
BEGIN
  FOR I:= 1 TO INDEX DO
    BEGIN
      PB[I]:= EXP(J*LN(P[I]));
      Y[I]:= LN(N[I]/PB[I])/LN(10);
    END;
    SUMXY:= 0;
    SOMY:= 0;
    FOR I:=1 TO INDEX DO
      BEGIN
        SUMXY:= (X[I]*Y[I])+SUMXY;
        SOMY:= SOMY+Y[I];
      END;
      A:=((INDEX*SUMXY)-(SUMX*SOMY));
      C:=((INDEX*SUMX2)-(SUMX*SUMX));
      B:=((SUMX2*SOMY)-(SUMX*SUMXY));
      A:=A/C;
      B:=B/C;
    END;
  END;
PROCEDURE COMPARE;
BEGIN
  SDIF:= 0;
  FOR I:= 1 TO INDEX DO
    BEGIN
      Y1[I]:= A*X[I]+B;
      DIF:= (Y[I]-Y1[I]);
      DIF:= DIF*DIF;
      SDIF:= SDIF+DIF;
    END;
  END;
PROCEDURE PRINT;
BEGIN
  GOTOXY(8,24);  WRITE('A = ');WRITE(A:6:3);
  GOTOXY(27,24); WRITE('B = ');WRITE(B:10:6);
  GOTOXY(42,24); WRITE('b = ');WRITE(J:6:3);
  GOTOXY(55,24); WRITE('LEAST OF SUM ');WRITE(SDIF:6:4);
END;
PROCEDURE FIRST;
BEGIN

```

```

J:= START;
J_MIN:=START;
IF START = STOP THEN RANGE:= 1
ELSE
  RANGE:= TRUNC((STOP -START)/STEP);
FOR K:= 1 TO RANGE DO
  BEGIN
    GOTOXY(7, 18);    WRITE(J_MIN:6:4);
    GOTOXY(31, 18);   WRITE(K:4);
    PROCESS;
    COMPARE;
    IF K= 1 THEN MIN:= SDIF;
    IF MIN>SDIF THEN
      BEGIN
        MIN:= SDIF;
        J_MIN:=J;
      END;
    J:=J+STEP;
  END;
J:=J_MIN;
PROCESS;
COMPARE;
PRINT;
END;
PROCEDURE READ_FILE;
LABEL AGAIN_I;
BEGIN
  GOTOXY(15, 11); WRITE('INPUT FILENAME OF DATA
  GOTOXY(40, 11); READLN(F_NAME1);
  ASSIGN(RR, F_NAME1);
  IF NOT CREATE(RR) THEN
    BEGIN
      GOTOXY(24, 23);
      WRITE('THIS FILE NOT FOUND ...');
      WRITE(#7);
      GOTO AGAIN_I;
    END;
    GOTOXY(24, 23);
    WRITE('
  ');
  RESET(RR);
  I2:=0;
  J2:=0;
  WHILE NOT EOF(RR) DO
    BEGIN
      I2:=I2+1;
      READ(RR, M[I2]);
      J2:=J2+1;
    END;
  CLOSE(RR);
  GOTOXY(12, 18);
  WRITE('THIS FILE ', F_NAME1, ' HAVE DATA TRANSFER = ', (J2/3):6:0, ' SERIES');
  I2:=0;
  L2:=INDEX;
  FOR K2:= 1 TO TRUNC(J2/3) DO
    BEGIN
      INDEX :=INDEX+1;
      I2:=I2+1;
      R[INDEX]:= M[I2];
    END;
  L1 :=L2;

```



```

FOR K2:= 1 TO TRUNC(J2/3) DO
BEGIN
    L2 :=L2 +1;
    I2:=I2+1;
    P{L2}:=M{I2};
END;
L2:= L1;
FOR K2:= 1 TO TRUNC(J2/3) DO
BEGIN
    I2:=I2+1;
    L2:=L2+1;
    M{L2}:=M{I2};
END;
FOR K2:= 1 TO J2 DO
    M{K2} := 0;
AGAIN_I :
END;
PROCEEDDE INPUT_FILENAME;
VAR OK : CLEAR;
BEGIN
    CLRSCR;
    I2:=0;
    J2:=0;
    OK := 'Y';
    GOTOXY(15,3); WRITE('INPUT NUMBER OF START ');
                READLN(START);
    GOTOXY(15,5); WRITE('INPUT NUMBER OF STOP ');
                READLN(STOP);
    GOTOXY(15,7); WRITE('INPUT NUMBER OF STEP ');
                READLN(STEP);
    REPEAT
        READ_FILE;
        GOTOXY(15,13); WRITE('YOU HAVE ANY FILE TO OPTIMIZED (Y/N)..');
        READ(KBD,OK);
    UNTIL UPCASE(OK) = 'N';
END;
BEGIN{MAIN}
    FOR I:= 1 TO 500 DO
        BEGIN
            R{I} := 0;
            P{I} := 0;
            N{I} := 0;
        END;
    FOR I:= 1 TO 500 DO
        M{I} := 0;
    INDEX := 0;
    INPUT_FILENAME;
    FOR I:= 1 TO INDEX DO
        X{I}:= LN(R{I})/LN(10);
SUMX:=0;
SUMX2:=0;
    FOR I:=1 TO INDEX DO
        BEGIN
            SUMX:= SUMX+X{I};
            SUMX2:= SUMX2+(X{I}*X{I});
        END;
    CLRSCR;
    GOTOXY(26,11);
    FIRST;
    END.

```

```

PROGRAM 3
TYPE FIVART =TEXT;
VAR F, F1, F2, BC1, BC2, BT1, BT2, BT, K1, K2, MEU1, MEU2 : ARRAY[1..3] OF REAL;
    U1, U2, U3, UT, DT1, DT2, TIN1, TIN2, TOUT1, TOUT2 : ARRAY[1..3] OF REAL;
    PR1, PR2, Q1, Q2, S_Q1, DP, DP1, DP2, NUT1, NUT2, UC : ARRAY[1..3] OF REAL;
    TLM, TR, TR1, TR2, TB1, TB2, RE1, RE2, NA, BC : ARRAY[1..3] OF REAL;
    NUC, NUC1, NUC2, BC, NUT : ARRAY[1..3] OF REAL;
    AVGQ, DE, AA, A, P, L, V, Y1, V3, VL, VL2, WJ, KJ : REAL;
    SU3, SUC, SUT : ARRAY[1..18] OF REAL;
    TU3, TUC, TUT : ARRAY[1..18] OF STRING[22];
    I, J, RES, NO : INTEGER;
    LINE55 : STRING[20];
    PP, CAS, P1 : CHAR;
    KK : STRING[2];
    U3_T, UC_T, UT_T : FIVART;
FUNCTION VOK(X1, X2, X3, X4, X5: REAL): REAL;
BEGIN
    VOK:=(((X1-X2)*X3)/X4)+X5;
END;
FUNCTION VOP(Y1, Y2, Y3, Y4, Y5: REAL): REAL;
BEGIN
    VOP:=Y5-(((Y1-Y2)*Y3)/Y4);
END;
PROCEDURE START;
BEGIN
    CLRSCR;
    GOTOXY(17, 5);
    WRITE(LINE55);
    GOTOXY(24, 6); WRITE('Tin');
    GOTOXY(31, 6); WRITE('Tout');
    GOTOXY(17, 7); WRITE(LINE55);
    GOTOXY(20, 8); WRITE('1');
    GOTOXY(17, 9); WRITE('3');
    GOTOXY(20, 10); WRITE('2');
    GOTOXY(17, 11); WRITE(LINE55);
    GOTOXY(20, 12); WRITE('1');
    GOTOXY(17, 13); WRITE('1');
    GOTOXY(20, 14); WRITE('2');
    GOTOXY(17, 15); WRITE(LINE55);
    GOTOXY(20, 16); WRITE('1');
    GOTOXY(17, 17); WRITE('2');
    GOTOXY(20, 18); WRITE('2');
    GOTOXY(17, 19); WRITE(LINE55);
    GOTOXY(15, 1);
    WRITE('THE VALUE OF V = ');
    READLN (V);
    GOTOXY(15, 2); WRITE('THE FLOW OF COOL WATER = ');
    READLN (V1);
    GOTOXY(15, 3); WRITE('THE FLOW OF HOT WATER = ');
    READLN (V3);
    FOR I:= 1 TO 3 DO
        BEGIN
            GOTOXY(24, (I*2)+I*2+4); READLN(TIN1[I]);
            GOTOXY(24, (I*2)+I*2+6); READLN(TIN2[I]);
        END;
    FOR I:= 1 TO 3 DO
        BEGIN
            GOTOXY(31, (I*2)+I*2+4); READLN(TOUT1[I]);
            GOTOXY(31, (I*2)+I*2+6); READLN(TOUT2[I]);
        END;
    END;

```

```

      END;
      READ(KBD,PP);
END;
PROCEDURE ACCZSS_1;
BEGIN
  IF TB1[I] < 26.68 THEN
    CAS:= 'A'
  ELSE
    IF TB1[I] < 32.23 THEN
      CAS:= '1'
    ELSE
      IF TB1[I] < 37.79 THEN
        CAS:= '2'
      ELSE
        IF TB1[I] < 48.9 THEN
          CAS:= '3'
        ELSE
          IF TB1[I] < 60.01 THEN
            CAS:= '4'
          ELSE
            IF TB1[I] < 71.12 THEN
              CAS:= '5'
            ELSE
              IF TB1[I] < 82.23 THEN
                CAS:= '6'
              ELSE
                IF TB1[I] < 93.34 THEN
                  CAS:= '7'
                ELSE
                  CAS:= '8';
CASE CAS OF
  'A' : BEGIN
    K1[I] := VOK(TB1[I], 21.11, 0.006, 5.56, 0.345)*1.49;
    PR1[I]:= VOP(TB1[I], 21.11, 0.91, 5.56, 6.83);
    END;
  '1' : BEGIN
    K1[I] := VOK(TB1[I], 26.67, 0.006, 5.55, 0.351)*1.49;
    PR1[I]:= VOP(TB1[I], 26.67, 0.74, 5.55, 5.92);
    END;
  '2' : BEGIN
    K1[I] := VOK(TB1[I], 32.22, 0.006, 5.56, 0.357)*1.49;
    PR1[I]:= VOP(TB1[I], 32.22, 0.61, 5.56, 5.18);
    END;
  '3' : BEGIN
    K1[I] := VOK(TB1[I], 37.78, 0.009, 11.11, 0.363)*1.49;
    PR1[I]:= VOP(TB1[I], 37.78, 0.92, 11.11, 4.57);
    END;
  '4' : BEGIN
    K1[I] := VOK(TB1[I], 48.89, 0.007, 11.11, 0.372)*1.49;
    PR1[I]:= VOP(TB1[I], 48.89, 0.64, 11.11, 3.65);
    END;
  '5' : BEGIN
    K1[I] := VOK(TB1[I], 60.0, 0.006, 11.11, 0.379)*1.49;
    PR1[I]:= VOP(TB1[I], 60.0, 0.49, 11.11, 3.01);
    END;
  '6' : BEGIN
    K1[I] := VOK(TB1[I], 71.11, 0.005, 11.11, 0.385)*1.49;
    PR1[I]:= VOP(TB1[I], 71.11, 0.36, 11.11, 2.52);
    END;
  '7' : BEGIN

```

```

      K1[I] := VOK(TB1[I], 32.22, 0.003, 11.11, 0.390)*1.49;
      PR1[I] := VOP(TB1[I], 32.22, 0.27, 11.11, 2.16);
    END;
  '3' : BEGIN
      K1[I] := VOK(TB1[I], 93.33, 0.002, 11.11, 0.393)*1.49;
      PR1[I] := VOP(TB1[I], 93.33, 0.227, 11.11, 1.39);
    END;
END;
PROCEDURE ACCESS_2;
BEGIN
  IF TB2[I] < 26.58 THEN
    CAS:= 'A'
  ELSE
    IF TB2[I] < 32.23 THEN
      CAS:= '1'
    ELSE
      IF TB2[I] < 37.79 THEN
        CAS:= '2'
      ELSE
        IF TB2[I] < 48.9 THEN
          CAS:= '3'
        ELSE
          IF TB2[I] < 60.01 THEN
            CAS:= '4'
          ELSE
            IF TB2[I] < 71.12 THEN
              CAS:= '5'
            ELSE
              IF TB2[I] < 82.23 THEN
                CAS:= '6'
              ELSE
                IF TB2[I] < 93.34 THEN
                  CAS:= '7'
                ELSE
                  CAS:= '8';
CASE CAS OF
  'A' : BEGIN
      K2[I] := VOK(TB2[I], 21.11, 0.006, 5.56, 0.345)*1.49;
      PR2[I] := VOP(TB2[I], 21.11, 0.91, 5.56, 6.83);
    END;
  '1' : BEGIN
      K2[I] := VOK(TB2[I], 26.67, 0.006, 5.55, 0.351)*1.49;
      PR2[I] := VOP(TB2[I], 26.67, 0.74, 5.55, 5.92);
    END;
  '2' : BEGIN
      K2[I] := VOK(TB2[I], 32.22, 0.006, 5.56, 0.357)*1.49;
      PR2[I] := VOP(TB2[I], 32.22, 0.81, 5.56, 5.18);
    END;
  '3' : BEGIN
      K2[I] := VOK(TB2[I], 37.78, 0.009, 11.11, 0.363)*1.49
      PR2[I] := VOP(TB2[I], 37.78, 0.92, 11.11, 4.57);
    END;
  '4' : BEGIN
      K2[I] := VOK(TB2[I], 48.89, 0.007, 11.11, 0.372)*1.49
      PR2[I] := VOP(TB2[I], 48.89, 0.64, 11.11, 3.65);
    END;
  '5' : BEGIN
      K2[I] := VOK(TB2[I], 60.0, 0.006, 11.11, 0.379)*1.49;
      PR2[I] := VOP(TB2[I], 60.0, 0.49, 11.11, 3.01);

```



```

        END;
'6' : BEGIN
      K2[I] := VOK(TB2[I], 71.11, 0.005, 11.11, 0.385)*1.49;
      PR2[I] := VOP(TB2[I], 71.11, 0.36, 11.11, 2.52);
      END;
'7' : BEGIN
      K2[I] := VOK(TB2[I], 82.22, 0.003, 11.11, 0.390)*1.49;
      PR2[I] := VOP(TB2[I], 82.22, 0.27, 11.11, 2.16);
      END;
'8' : BEGIN
      K2[I] := VOK(TB2[I], 93.33, 0.002, 11.11, 0.393)*1.49;
      PR2[I] := VOP(TB2[I], 93.33, 0.227, 11.11, 1.89);
      END;
END;
PROCEDURE ACCESS_3;
BEGIN
  Q1[I] := V1 * DT1[I];
  Q2[I] := V2 * DT2[I];
  AVGQ := (ABS(Q1[I]) + ABS(Q2[I]))/2;
  IF TLM[I] = 0 THEN
    U1[I] := 0
  ELSE
    U1[I] := (AVGQ*60* 0.001)/(NA[I]* TLM[I]);
  U2[I] := U1[I] / 4.88;
  U3[I] := U2[I] * 5.6783;
  VL := (V1/(2*60*1.0E+06))/A;
  VL2 := (V2/(2*60*1.0E+06))/A;
  RE1[I] := (DE *VL *P)/(MEU1[I]*0.001);
  RE2[I] := (DE *VL2 *P)/(MEU2[I]*0.001);
END;
PROCEDURE ACCESS_4;
BEGIN
  Q1[I] := V * DT1[I];
  Q2[I] := V * DT2[I];
  AVGQ := (ABS(Q1[I]) + ABS(Q2[I])) / 2;
  IF TLM[I] = 0 THEN
    U1[I] := 0
  ELSE
    U1[I] := (AVGQ*60* 0.001)/(NA[I]* TLM[I]);
  U2[I] := U1[I] / 4.88;
  U3[I] := U2[I] * 5.6783;
  VL := (V/(2*60*1.0E+06))/A;
  RE1[I] := (DE*VL*P)/(MEU1[I]*0.001);
  RE2[I] := (DE*VL*P)/(MEU2[I]*0.001);
  RC[I] := (RE1[I] +RE2[I])/2;
END;
PROCEDURE ACCESS_5;
BEGIN
  Q1[I] := V * DT1[I];
  Q2[I] := V3 * DT2[I];
  AVGQ := (ABS(Q1[I]) + ABS(Q2[I])) / 2;
  IF TLM[I] = 0 THEN
    U1[I] := 0
  ELSE
    U1[I] := (AVGQ*60* 0.001)/(NA[I]* TLM[I]);
  U2[I] := U1[I] / 4.88;
  U3[I] := U2[I] * 5.6783;
  VL := (V/(2*60*1.0E+06))/A;
  RE1[I] := (DE *VL * P)/(MEU1[I]*0.001);

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```

VL2 := ((V3/2+V3/3)/(2*60*1.0E+06))/A;
BE2[I] := (DE*VL2*P)/(HEU2[I]*0.001);

END;
PROCEDURE PROCESSE;
BEGIN
  FOR I := 1 TO 3 DO
    BEGIN
      BEGIN
        TB1[I] := (TIN1[I] + TOUT1[I]) / 2;
        TB2[I] := (TIN2[I] + TOUT2[I]) / 2;
      END;
      BEGIN
        HEU1[I] := (1/(2.1482*((TB1[I]-8.435)+SQRT(8078.4+((TB1[I]-8.435)*(TB1[I]-8.435))))-120))*100;
        HEU2[I] := (1/(2.1482*((TB2[I]-8.435)+SQRT(8078.4+((TB2[I]-8.435)*(TB2[I]-8.435))))-120))*100;
      END;
      ACCESS_1;
      ACCESS_2;
      DT1[I] := TOUT1[I] - TIN1[I];
      DT2[I] := TOUT2[I] - TIN2[I];
      IF (TOUT2[I] - TIN1[I]) = 0 THEN
        TLM[I] := ((TOUT2[I] + TIN2[I]) - (TOUT1[I] + TIN1[I]))/2
      ELSE
        IF (TIN2[I] - TOUT1[I]) / (TOUT2[I] - TIN1[I]) < 2.5 THEN
          TLM[I] := ((TOUT2[I] + TIN2[I]) - (TOUT1[I] + TIN1[I]))/2
        ELSE
          TLM[I] := ((TIN2[I]-TOUT1[I])-(TOUT2[I]-TIN1[I]))/LN((TIN2[I]-TOUT1[I])/(TOUT2[I]-TIN1[I]));
        END
      END;
      IF I = 1 THEN ACCESS_3;
      IF I = 2 THEN ACCESS_4;
      IF I = 3 THEN ACCESS_5;
      IF I = 2 THEN
        BEGIN
          HC1[I] := (0.006281*EXP(0.957*LN(RE1[I]))*EXP(1.38*LN(PR1[I]))*K1[I])/DE;
          HC2[I] := (0.006281*EXP(0.957*LN(RE2[I]))*EXP(1.38*LN(PR2[I]))*K2[I])/DE;
          HC[I] := (HC1[I] + HC2[I]) / 2;
          HOC1[I] := HC1[I]*DE/K1[I];
          HOC2[I] := HC2[I]*DE/K2[I];
          HOC[I] := HC[I]*DE/((K1[I]+K2[I])/2);
          HT1[I] := (0.2*EXP(0.67*LN(RE1[I]))*EXP(0.4*LN(PR1[I]))*K1[I])/DE;
          HT2[I] := (0.2*EXP(0.67*LN(RE2[I]))*EXP(0.4*LN(PR2[I]))*K2[I])/DE;
          HT[I] := (HT1[I] + HT2[I]) / 2;
          NOT1[I] := HT1[I]*DE/K1[I];
          NOT2[I] := HT2[I]*DE/K2[I];
          NOT[I] := HT[I]*DE/((K1[I]+K2[I])/2);
        END
      ELSE
        BEGIN
          HC1[I] := (0.006281*EXP(0.957*LN(RE1[I]))*EXP(1.38*LN(PR1[I]))*K1[I])/DE;
          HC2[I] := (0.006281*EXP(0.957*LN(RE2[I]))*EXP(1.38*LN(PR2[I]))*K2[I])/DE;
          HOC1[I] := HC1[I]*DE/K1[I];
          HOC2[I] := HC2[I]*DE/K2[I];
          HT1[I] := (0.2*EXP(0.67*LN(RE1[I]))*EXP(0.4*LN(PR1[I]))*K1[I])/DE;
          HT2[I] := (0.2*EXP(0.67*LN(RE2[I]))*EXP(0.4*LN(PR2[I]))*K2[I])/DE;
          NOT1[I] := HT1[I]*DE/K1[I];
          NOT2[I] := HT2[I]*DE/K2[I];
        END
      END;
      OT[I] := 1 / ( (1/HT1[I]) + ((0.6*0.001)/14.006) + (1/HT2[I]) );
      UT[I] := OT[I]/4.88;
      OT[I] := OT[I]*5.6783;
      UC[I] := 1 / ( (1/HC1[I]) + ((0.6*0.001)/14.006) + (1/HC2[I]) );
    END
  END

```

```

        UC{I} := UC{I}/4.88;
        UC{I} := UC{I}*5.6783;
    END;
END;
PROCEDURE SAVE_DETAIL;
BEGIN
    U3{NO}:= U3{1};
    U3{NO+1}:= U3{2};
    U3{NO+2}:= U3{3};
    UC{NO}:= UC{1};
    UC{NO+1}:= UC{2};
    UC{NO+2}:= UC{3};
    UT{NO}:= UT{1};
    UT{NO+1}:= UT{2};
    UT{NO+2}:= UT{3};
    STR(U3{1}:22:18,TU3{NO});
    STR(U3{2}:22:18,TU3{NO+1});
    STR(U3{3}:22:18,TU3{NO+2});
    STR(UC{1}:22:18,TUC{NO});
    STR(UC{2}:22:18,TUC{NO+1});
    STR(UC{3}:22:18,TUC{NO+2});
    STR(UT{1}:22:18,TUT{NO});
    STR(UT{2}:22:18,TUT{NO+1});
    STR(UT{3}:22:18,TUT{NO+2});
    NO:=NO+3;
END;
PROCEDURE SAVE_FILE;
BEGIN
    ASSIGN(U3_T,'U3_T.TXT');
    REWRITE(U3_T);
    FOR I:=1 TO 18 DO
        WRITELN(U3_T,TU3{I});
    CLOSE(U3_T);
    ASSIGN(UC_T,'UC_T.TXT');
    REWRITE(UC_T);
    FOR I:=1 TO 18 DO
        WRITELN(UC_T,TUC{I});
    CLOSE(UC_T);
    ASSIGN(UT_T,'UT_T.TXT');
    REWRITE(UT_T);
    FOR I:=1 TO 18 DO
        WRITELN(UT_T,TUT{I});
    CLOSE(UT_T);
END;
BEGIN{MAIN}
NA{1} := 0.55;
NA{2} := 1.75;
NA{3} := 0.4;
AA := 0.05;
DE := 6.26 * 0.001;
A := 11.25 * 0.0001 * 0.313;
P := 1000;
L := 44.5 * 0.01;
LINE55:= '-----';
NO:= 1;
BEGIN
    REPEAT
        BEGIN
            START;
            PROCESS;

```

```
GOTOXY(14,24); WRITE('ARE YOU SURE TO SAVE (Y/N) ? ');  
READ(KBD,PP);  
IF UPCASE(PP) = 'Y' THEN SAVE_DETAIL;  
GOTOXY(14,24); WRITE('DO YOU WANT TO TEST (Y/N) ? ');  
READ(KBD,PP);  
END;  
UNTIL UPCASE(PP) = 'N';  
END;  
SAVE_FILE;  
END.
```

```

PROGRAM 4
TYPE FIVARR = FILE OF REAL;
      FIVART = TEXT;
VAR H01, H02, H0F1, H0F2, HTO1, HTO2, HTOF1, HTOF2, DO, DOF, DTO, DTOF: ARRAY[1..3] OF REAL;
    F, F1, F2, H, HT, HT1, HT2, H_T1, H_T2, HW1, HW2, H_W1, H_W2 : ARRAY[1..3] OF REAL;
    S_K1, S_K2, K1, K2, HED1, HED2, S_HED1, S_HED2, DC, BC, H_S1 : ARRAY[1..3] OF REAL;
    D1, D2, D3, DT, DT1, DT2, TIN1, TIN2, TOUT1, TOUT2, H_S2 : ARRAY[1..3] OF REAL;
    PR1, PR2, S_PR1, S_PR2, Q1, Q2, S_Q1, S_Q2, OCC, HS1, HS2 : ARRAY[1..3] OF REAL;
    TLM, TB1, TB2, RE1, RE2, NA, RC, HSCCC1, HSCCC2, HWCC1 : ARRAY[1..3] OF REAL;
    HWCC2, HSCC1, HSCC2, HWCCC1, HWCCC2, NU, NU_T1, NU_T2, NUT1, NUT2, NUT : ARRAY[1..3] OF REAL;
    NUC, NUC1, NUC2, NUCC1, NUCC2, NUCC1, NUCC2 : ARRAY[1..3] OF REAL;
    AVGQ, DE, AA, A, P, PS, BR, AS, BS, S_D, L, V, VL, VL2, WJ, KJ: REAL;
    SS_TPR, SS_TRE, SS_TNO, WS_TPR, WS_TRE, TNUC, TNUCC, TNUCC : ARRAY[1..100] OF REAL;
    TU32, TU02, TUOF2, TUT2, TUTO2, TUTOF2 : ARRAY[1..50] OF REAL;
    TU313, TUT13, TUTO13, TUTOF13 : ARRAY[1..100] OF REAL;
    ST_TPR, ST_TRE, ST_TNO, WT_TPR, WT_TRE, TNUT, TNUCT, TNUCCT : ARRAY[1..100] OF STRING[22];
    TU32T, TU02T, TUOF2T, TUT2T, TUTO2T, TUTOF2T : ARRAY[1..50] OF STRING[22];
    TU313T, TUT13T, TUTO13T, TUTOF13T : ARRAY[1..100] OF STRING[22];
    SS_RE_M, SS_PR_M, SS_NO_M, RE_M, PR_M, NO_M, NO_N, NO_O : ARRAY[1..200] OF REAL;
    I, J, RES, INDEX1, INDEX2 : INTEGER;
    LINE55 : STRING[20];
    PP, CAS, P1 : CHAR;
    KK : STRING[2];
    FILE_NAME : STRING[15];
    RR : FIVARR;
    P_T : FIVART;
FUNCTION S_YOK(Z1, Z2, Z3, Z4, Z5, Z6: REAL): REAL;
    BEGIN
    S_YOK := (Z1*Z2*(Z6-(Z3*Z4*Z5)));
    END;
FUNCTION S_VOP(O1, O2, O3, O4, O5: REAL): REAL;
    BEGIN
    S_VOP := ((O5-(O1*O2))*O3)/O4;
    END;
FUNCTION VOK(X1, X2, X3, X4, X5: REAL): REAL;
    BEGIN
    VOK := (((X1-X2)*X3)/X4)+X5;
    END;
FUNCTION VOP(Y1, Y2, Y3, Y4, Y5: REAL): REAL;
    BEGIN
    VOP := Y5-(((Y1-Y2)*Y3)/Y4);
    END;
PROCEDURE START;
LABEL AGAIN;
VAR OK : CHAR;
BEGIN
AGAIN:
    CLRSCR;
    GOTOXY(17, 5);
    WRITE(LINE55);
    GOTOXY(24, 6); WRITE('Tin');
    GOTOXY(31, 6); WRITE('Tout');
    GOTOXY(17, 7); WRITE(LINE55);
    GOTOXY(20, 8); WRITE('1');
    GOTOXY(17, 9); WRITE('3');
    GOTOXY(20, 10); WRITE('2');
    GOTOXY(17, 11); WRITE(LINE55);
    GOTOXY(20, 12); WRITE('1');
    GOTOXY(17, 13); WRITE('1');
    GOTOXY(20, 14); WRITE('2');

```



```

GOTOXY(17,15); WRITE(LINE55);
GOTOXY(20,16); WRITE('1');
GOTOXY(17,17); WRITE('2');
GOTOXY(20,18); WRITE('2');
GOTOXY(17,19); WRITE(LINE55);
GOTOXY(15,1); WRITE('DENSITY OF SUCROSE SOLUTION = ');
READLN(S_D);
GOTOXY(44,1);
WRITE(S_D:9:6);
GOTOXY(15,3);
WRITE('THE VALUE OF V = ');
READLN (V);
GOTOXY(32,3);
WRITE(V:7:2);
GOTOXY(15,21); WRITE('Grams of solute per 100 g of solution = ');
READLN (PS);
GOTOXY(55,21);
WRITE(PS:6:2);
GOTOXY(15,23); WRITE('%Brix = ');
READLN (BR);
GOTOXY(23,23);
WRITE(BR:6:2);
GOTOXY(29,23); WRITE('S_MEU,slope = ');
READLN (AS);
GOTOXY(44,23);
WRITE(AS:9:4);
GOTOXY(53,23); WRITE('intercept = ');
READLN (BS);
GOTOXY(66,23);
WRITE(BS:10:5);
FOR I:= 1 TO 3 DO
  BEGIN
    GOTOXY(24,(I*2)+I*2+4); READLN(TIN1[I]);
    GOTOXY(24,(I*2)+I*2+4); WRITE(TIN1[I]:5:2);
    GOTOXY(24,(I*2)+I*2+6); READLN(TIN2[I]);
    GOTOXY(24,(I*2)+I*2+6); WRITE(TIN2[I]:5:2);
  END;
FOR I:= 1 TO 3 DO
  BEGIN
    GOTOXY(31,(I*2)+I*2+4); READLN(TOUT1[I]);
    GOTOXY(31,(I*2)+I*2+4); WRITE(TOUT1[I]:5:2);
    GOTOXY(31,(I*2)+I*2+6); READLN(TOUT2[I]);
    GOTOXY(31,(I*2)+I*2+6); WRITE(TOUT2[I]:5:2);
  END;
GOTOXY(20,24);
WRITE('ARE YOU SURE IN THIS DATA...(Y/N)...');
REPEAT
  GOTOXY(60,24);
  READ(KBD,OK);
  IF UPCASE(OK) = 'N' THEN
    GOTO AGAIN;
UNTIL UPCASE(OK) IN ['Y','N'];
END;
PROCEDURE FIND_S_MEU;
BEGIN
  BEGIN
    S_MEU1[I]:= EXP(((AS/(TB1[I]+273)) + BS)*LN(10));
    S_MEU2[I]:= EXP(((AS/(TB2[I]+273)) + BS)*LN(10));
  END;

```

```

END;
PROCEDURE ACCESS_1;
BEGIN
    IF TB1[I] < 26.68 THEN
        CAS = 'A'
    ELSE
        IF TB1[I] < 32.23 THEN
            CAS = '1'
        ELSE
            IF TB1[I] < 37.79 THEN
                CAS = '2'
            ELSE
                IF TB1[I] < 48.9 THEN
                    CAS = '3'
                ELSE
                    IF TB1[I] < 60.01 THEN
                        CAS = '4'
                    ELSE
                        IF TB1[I] < 71.12 THEN
                            CAS = '5'
                        ELSE
                            IF TB1[I] < 82.23 THEN
                                CAS = '6'
                            ELSE
                                IF TB1[I] < 93.34 THEN
                                    CAS = '7'
                                ELSE
                                    CAS = '8';
                                CASE CAS OF
                                    'A' : BEGIN
                                        K1[I] := VOK(TB1[I], 21.11, 0.006, 5.56, 0.345)*1.49;
                                        PR1[I] := VOP(TB1[I], 21.11, 0.91, 5.56, 6.83);
                                    END;
                                    '1' : BEGIN
                                        K1[I] := VOK(TB1[I], 26.67, 0.006, 5.55, 0.351)*1.49;
                                        PR1[I] := VOP(TB1[I], 26.67, 0.74, 5.55, 5.92);
                                    END;
                                    '2' : BEGIN
                                        K1[I] := VOK(TB1[I], 32.22, 0.006, 5.56, 0.357)*1.49;
                                        PR1[I] := VOP(TB1[I], 32.22, 0.61, 5.56, 5.18);
                                    END;
                                    '3' : BEGIN
                                        K1[I] := VOK(TB1[I], 37.78, 0.009, 11.11, 0.363)*1.49;
                                        PR1[I] := VOP(TB1[I], 37.78, 0.92, 11.11, 4.57);
                                    END;
                                    '4' : BEGIN
                                        K1[I] := VOK(TB1[I], 48.89, 0.007, 11.11, 0.372)*1.49;
                                        PR1[I] := VOP(TB1[I], 48.89, 0.64, 11.11, 3.65);
                                    END;
                                    '5' : BEGIN
                                        K1[I] := VOK(TB1[I], 60.0, 0.006, 11.11, 0.379)*1.49;
                                        PR1[I] := VOP(TB1[I], 60.0, 0.49, 11.11, 3.01);
                                    END;
                                    '6' : BEGIN
                                        K1[I] := VOK(TB1[I], 71.11, 0.005, 11.11, 0.385)*1.49;
                                        PR1[I] := VOP(TB1[I], 71.11, 0.36, 11.11, 2.52);
                                    END;
                                    '7' : BEGIN
                                        K1[I] := VOK(TB1[I], 82.22, 0.003, 11.11, 0.390)*1.49;
                                        PR1[I] := VOP(TB1[I], 82.22, 0.27, 11.11, 2.16);

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```

        END;
    '8' : BEGIN
        K1[I] := VOK(TB1[I], 93.33, 0.002, 11.11, 0.393)*1.49;
        PR1[I] := VOP(TB1[I], 93.33, 0.227, 11.11, 1.89);
    END;
END;
END;
PROCEDURE ACCESS_2;
BEGIN
    IF TB2[I] < 26.68 THEN
        CAS := 'A'
    ELSE
        IF TB2[I] < 32.23 THEN
            CAS := '1'
        ELSE
            IF TB2[I] < 37.79 THEN
                CAS := '2'
            ELSE
                IF TB2[I] < 48.9 THEN
                    CAS := '3'
                ELSE
                    IF TB2[I] < 60.01 THEN
                        CAS := '4'
                    ELSE
                        IF TB2[I] < 71.12 THEN
                            CAS := '5'
                        ELSE
                            IF TB2[I] < 82.23 THEN
                                CAS := '6'
                            ELSE
                                IF TB2[I] < 93.34 THEN
                                    CAS := '7'
                                ELSE
                                    CAS := '8';
                                END;
                            END;
                        END;
                    END;
                END;
            END;
        END;
    END;
CASE CAS OF
    'A' : BEGIN
        K2[I] := VOK(TB2[I], 21.11, 0.006, 5.56, 0.345)*1.49;
        PR2[I] := VOP(TB2[I], 21.11, 0.91, 5.56, 6.83);
    END;
    '1' : BEGIN
        K2[I] := VOK(TB2[I], 26.67, 0.006, 5.55, 0.351)*1.49;
        PR2[I] := VOP(TB2[I], 26.67, 0.74, 5.55, 5.92);
    END;
    '2' : BEGIN
        K2[I] := VOK(TB2[I], 32.22, 0.006, 5.56, 0.357)*1.49;
        PR2[I] := VOP(TB2[I], 32.22, 0.61, 5.56, 5.18);
    END;
    '3' : BEGIN
        K2[I] := VOK(TB2[I], 37.78, 0.009, 11.11, 0.363)*1.49;
        PR2[I] := VOP(TB2[I], 37.78, 0.92, 11.11, 4.57);
    END;
    '4' : BEGIN
        K2[I] := VOK(TB2[I], 48.89, 0.007, 11.11, 0.372)*1.49;
        PR2[I] := VOP(TB2[I], 48.89, 0.64, 11.11, 3.65);
    END;
    '5' : BEGIN
        K2[I] := VOK(TB2[I], 60.0, 0.006, 11.11, 0.379)*1.49;
        PR2[I] := VOP(TB2[I], 60.0, 0.49, 11.11, 3.01);
    END;
    '6' : BEGIN

```



```

      K2[I] := VOK(TB2[I], 71.11, 0.005, 11.11, 0.385)*1.49;
      PR2[I] := VOP(TB2[I], 71.11, 0.36, 11.11, 2.52);
      END;
'7' : BEGIN
      K2[I] := VOK(TB2[I], 82.22, 0.003, 11.11, 0.390)*1.49;
      PR2[I] := VOP(TB2[I], 82.22, 0.27, 11.11, 2.16);
      END;
'8' : BEGIN
      K2[I] := VOK(TB2[I], 93.33, 0.002, 11.11, 0.393)*1.49;
      PR2[I] := VOP(TB2[I], 93.33, 0.227, 11.11, 1.89);
      END;
END;
END;
PROCEDURE ACCESS_3;
BEGIN
  IF TB1[I] < 26.68 THEN
    CAS := 'A'
  ELSE
    IF TB1[I] < 32.23 THEN
      CAS := '1'
    ELSE
      IF TB1[I] < 37.79 THEN
        CAS := '2'
      ELSE
        IF TB1[I] < 48.9 THEN
          CAS := '3'
        ELSE
          IF TB1[I] < 60.01 THEN
            CAS := '4'
          ELSE
            IF TB1[I] < 71.12 THEN
              CAS := '5'
            ELSE
              IF TB1[I] < 82.23 THEN
                CAS := '6'
              ELSE
                IF TB1[I] < 93.34 THEN
                  CAS := '7'
                ELSE
                  CAS := '8';
CASE CAS OF
'A' : BEGIN
      S_K1[I] := S_VOK(K1[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
      S_PR1[I] := S_VOP(0.006, BR, S_MED1[I], S_K1[I], 1)*3.6;
      END;
'1' : BEGIN
      S_K1[I] := S_VOK(K1[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
      S_PR1[I] := S_VOP(0.006, BR, S_MED1[I], S_K1[I], 1)*3.6;
      END;
'2' : BEGIN
      S_K1[I] := S_VOK(K1[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
      S_PR1[I] := S_VOP(0.006, BR, S_MED1[I], S_K1[I], 1)*3.6;
      END;
'3' : BEGIN
      S_K1[I] := S_VOK(K1[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
      S_PR1[I] := S_VOP(0.006, BR, S_MED1[I], S_K1[I], 1)*3.6;
      END;
'4' : BEGIN
      S_K1[I] := S_VOK(K1[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
      S_PR1[I] := S_VOP(0.006, BR, S_MED1[I], S_K1[I], 1)*3.6;

```

```

END;
'5' : BEGIN
    S_K1[I] := S_VCK(K1[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
    S_PR1[I] := S_VCP(0.006, BR, S_MEU1[I], S_K1[I], 1)*3.6;
END;
'6' : BEGIN
    S_K1[I] := S_VCK(K1[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
    S_PR1[I] := S_VCP(0.006, BR, S_MEU1[I], S_K1[I], 1)*3.6;
END;
'7' : BEGIN
    S_K1[I] := S_VCK(K1[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
    S_PR1[I] := S_VCP(0.006, BR, S_MEU1[I], S_K1[I], 1)*3.6;
END;
'8' : BEGIN
    S_K1[I] := S_VCK(K1[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
    S_PR1[I] := S_VCP(0.006, BR, S_MEU1[I], S_K1[I], 1)*3.6;
END;
END;
END;
PROCEDURE ACCESS_4;
BEGIN
    IF TB2[I] < 26.38 THEN
        CAS := 'A'
    ELSE
        IF TB2[I] < 32.23 THEN
            CAS := '1'
        ELSE
            IF TB2[I] < 37.79 THEN
                CAS := '2'
            ELSE
                IF TB2[I] < 48.9 THEN
                    CAS := '3'
                ELSE
                    IF TB2[I] < 60.01 THEN
                        CAS := '4'
                    ELSE
                        IF TB2[I] < 71.12 THEN
                            CAS := '5'
                        ELSE
                            IF TB2[I] < 82.23 THEN
                                CAS := '6'
                            ELSE
                                IF TB2[I] < 93.34 THEN
                                    CAS := '7'
                                ELSE
                                    CAS := '3';
                                END;
                            END;
                        END;
                    END;
                END;
            END;
        END;
    END;
CASE CAS OF
    'A' : BEGIN
        S_K2[I] := S_VCK(K2[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
        S_PR2[I] := S_VCP(0.006, BR, S_MEU2[I], S_K2[I], 1)*3.6;
    END;
    '1' : BEGIN
        S_K2[I] := S_VCK(K2[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
        S_PR2[I] := S_VCP(0.006, BR, S_MEU2[I], S_K2[I], 1)*3.6;
    END;
    '2' : BEGIN
        S_K2[I] := S_VCK(K2[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
        S_PR2[I] := S_VCP(0.006, BR, S_MEU2[I], S_K2[I], 1)*3.6;
    END;
    '3' : BEGIN

```

```

S_K2[I] := S_VOK(K2[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
S_PR2[I] := S_VOP(0.006, BR, S_MEU2[I], S_K2[I], 1)*3.6;
END;
'4' : BEGIN
S_K2[I] := S_VOK(K2[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
S_PR2[I] := S_VOP(0.006, BR, S_MEU2[I], S_K2[I], 1)*3.6;
END;
'5' : BEGIN
S_K2[I] := S_VOK(K2[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
S_PR2[I] := S_VOP(0.006, BR, S_MEU2[I], S_K2[I], 1)*3.6;
END;
'6' : BEGIN
S_K2[I] := S_VOK(K2[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
S_PR2[I] := S_VOP(0.006, BR, S_MEU2[I], S_K2[I], 1)*3.6;
END;
'7' : BEGIN
S_K2[I] := S_VOK(K2[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
S_PR2[I] := S_VOP(0.006, BR, S_MEU2[I], S_K2[I], 1)*3.6;
END;
'3' : BEGIN
S_K2[I] := S_VOK(K2[I], 0.01163, EXP((-5)*LN(10)), 556, PS, 1)*100/1.163;
S_PR2[I] := S_VOP(0.006, BR, S_MEU2[I], S_K2[I], 1)*3.6;
END;
END;
PROCEDURE ACCESS_5;
BEGIN
{ WATER/SYROP }
Q1[I] := V * DT1[I];
S_Q2[I] := V * S_D * (1 - (0.006*BR)) * DT2[I];
AVGQ := (ABS(Q1[I]) + ABS(S_Q2[I]))/2;
IF TLM[I] = 0 THEN
    U1[I] := 0
ELSE
    U1[I] := (AVGQ*60* 0.001)/(NA[I]* TLM[I]);
U2[I] := U1[I] / 4.88;
U3[I] := U2[I] * 5.6783;
VL := (V/(2*60*1.0E+06))/A;
RE1[I] := (DE *VL *P)/(MEU1[I]*0.001);
RE2[I] := (DE*VL*S_D*1000)/(S_MEU2[I]*0.001);
{CASE C-1 =THEORY}
HT1[I] := (0.2*(EXP(0.67*LN(RE1[I])))*(EXP(0.4*LN(PR1[I])))*K1[I])/DE;
HT2[I] := (0.2*(EXP(0.67*LN(RE2[I])))*(EXP(0.4*LN(S_PR2[I])))*S_K2[I])/DE;
UT1[I] := 1 / ((1/HT1[I]) + ((0.6*0.001)/14.006) + (1/HT2[I]));
UT1[I] := UT1[I] / 4.88;
UT1[I] := UT1[I]*5.6783;
NUT1[I] := HT1[I] *DE / K1[I];
NUT2[I] := HT2[I] *DE / S_K2[I];
{CASE C-2 = TOTAL OPT. }
HTO1[I] := (0.02*(EXP(0.67*LN(RE1[I])))*(EXP(0.78*LN(PR1[I])))*K1[I])/DE;
HTO2[I] := (0.02*(EXP(0.67*LN(RE2[I])))*(EXP(0.78*LN(S_PR2[I])))*S_K2[I])/DE;
UTO1[I] := 1 / ((1/HTO1[I]) + ((0.6*0.001)/14.006) + (1/HTO2[I]));
UTO1[I] := UTO1[I] / 4.88;
UTO1[I] := UTO1[I]*5.6783;
{CASE C-3 = TOTAL OPT. F }
HTOF1[I] := (0.4*(EXP(0.55*LN(RE1[I])))*(EXP(0.4*LN(PR1[I])))*K1[I])/DE;
HTOF2[I] := (0.4*(EXP(0.55*LN(RE2[I])))*(EXP(0.4*LN(S_PR2[I])))*S_K2[I])/DE;
UTOF1[I] := 1 / ((1/HTOF1[I]) + ((0.6*0.001)/14.006) + (1/HTOF2[I]));
UTOF1[I] := UTOF1[I] / 4.88;
UTOF1[I] := UTOF1[I]*5.6783;

```

```

{CASE NC-1 = Bw USE CORRELATION FROM THEORY}
HT1[I] := (0.2*(EXP(0.67*LN(RE1[I])))*(EXP(0.4*LN(PR1[I])))*K1[I])/DE;
H_T2[I]:= U1[I]/(1-U1[I]*(1/HT1[I]+(0.0006/14.006)));
NHT1[I]:= HT1[I]*DE/K1[I];
NU_T2[I]:= H_T2[I]*DE/S_K2[I];
{CASE NC-2 = Bw USE CORRELATION FROM OPT.}
HWCC1[I] := (0.006281*(EXP(0.957*LN(RE1[I])))*(EXP(1.33*LN(PR1[I])))*K1[I])/DE;
HSCC2[I]:= U1[I]/(1-U1[I]*(1/HWCC1[I]+(0.0006/14.006)));
NHWCC1[I]:= HWCC1[I]*DE/K1[I];
NSCC2[I]:= HSCC2[I]*DE/S_K2[I];
{CASE NC-3 = Bw USE CORRELATION FROM OPT.F}
HWCCC1[I] := (0.17755*EXP(0.659*LN(RE1[I]))*(EXP(0.4*LN(PR1[I])))*K1[I])/DE;
HSCCC2[I]:= U1[I]/(1-U1[I]*(1/HWCCC1[I]+(0.0006/14.006)));
NHWCCC1[I]:= HWCCC1[I]*DE/K1[I];
NSCCC2[I]:= HSCCC2[I]*DE/S_K2[I];
END;
PROCEDURE ACCESS_6;
BEGIN
  { SYROP/SYROP }
  S_Q1[I]:= V * S_D * (1-(0.006*BR)) * DT1[I];
  S_Q2[I]:= V * S_D * (1-(0.006*BR)) * DT2[I];
  AVGQ:= ( ABS(S_Q1[I]) + ABS(S_Q2[I]) ) / 2;
  IF TLM[I] = 0 THEN
    U1[I]:= 0
  ELSE
    U1[I]:= (AVGQ*60* 0.001)/(NA[I]* TLM[I]);
  U2[I]:= U1[I] / 4.88;
  U3[I]:= U2[I] * 5.6783;
  VL := (V/(2*60*1.0E+06))/A;
  RE1[I]:= (DE*VL*S_D*1000)/(S_MEU1[I]*0.001);
  RE2[I]:= (DE*VL*S_D*1000)/(S_MEU2[I]*0.001);
  RC[I] := (RE1[I] +RE2[I])/2;
  {CASE C+}
  H[I] := (2*U1[I])/((1-U1[I]*((0.6*0.001)/14.006)));
  NU[I] := H[I] * DE / ((S_K1[I] + S_K2[I])/2);
  {CASE C-1 = THEORY }
  HT1[I]:= (0.2*(EXP(0.67*LN(RE1[I]))*(EXP(0.4*LN(S_PR1[I])) * S_K1[I])/DE;
  HT2[I]:= (0.2*(EXP(0.67*LN(RE2[I]))*(EXP(0.4*LN(S_PR2[I])) * S_K2[I])/DE;
  HT[I] := (HT1[I] + HT2[I])/2;
  NHT[I]:= HT[I] * DE / ((S_K1[I] + S_K2[I])/2);
  UT[I] := 1 / ((1/HHT1[I]) + ((0.6*0.001)/14.006) + ( 1/HT2[I]));
  UT[I] := UT[I] / 4.88;
  UT[I] := UT[I]*5.6783;
  {CASE C-2 = SUGAR OPT }
  H01[I] := (0.07*(EXP(0.9*LN(RE1[I]))*(EXP(0.54*LN(S_PR1[I])))*S_K1[I])/DE;
  H02[I] := (0.07*(EXP(0.9*LN(RE2[I]))*(EXP(0.54*LN(S_PR2[I])))*S_K2[I])/DE;
  U0[I] := 1 / ((1/H01[I]) + ((0.6*0.001)/14.006) + ( 1/H02[I]));
  U0[I] := U0[I] /4.88;
  U0[I] := U0[I]*5.6783;
  {CASE C-3 = SUGAR OPT.F }
  H0F1[I]:= (0.15*(EXP(0.72*LN(RE1[I]))*(EXP(0.4*LN(S_PR1[I])))*S_K1[I])/DE;
  H0F2[I]:= (0.15*(EXP(0.72*LN(RE2[I]))*(EXP(0.4*LN(S_PR2[I])))*S_K2[I])/DE;
  U0F[I] := 1 / ((1/H0F1[I]) + ((0.6*0.001)/14.006) + ( 1/H0F2[I]));
  U0F[I] := U0F[I] /4.88;
  U0F[I] := U0F[I]*5.6783;
  {CASE C-4 = TOTAL OPT }
  HT01[I]:= (0.02*(EXP(0.87*LN(RE1[I]))*(EXP(0.78*LN(S_FR1[I])))*S_K1[I])/DE;
  HT02[I]:= (0.02*(EXP(0.87*LN(RE2[I]))*(EXP(0.78*LN(S_FR2[I])))*S_K2[I])/DE;
  UTO[I] := 1 / ((1/HT01[I]) + ((0.6*0.001)/14.006) + ( 1/HT02[I]));

```

```

      UTO[I] := UTO[I] /4.38;
      UTO[I] := UTO[I]*5.6783;
{CASE C-5 = TOTAL OPT.F }
      HTOF1[I]:= (0.4*(EXP(0.55*LN(RE1[I])))*(EXP(0.4*LN(S_PR1[I])))*S_K1[I])/DE;
      HTOF2[I]:= (0.4*(EXP(0.55*LN(RE2[I])))*(EXP(0.4*LN(S_PR2[I])))*S_K2[I])/DE;
      UTOF[I] := 1 / ((1/HTOF1[I]) + ((0.6*0.001)/14.006) + ( 1/HTOF2[I]));
      UTOF[I] := UTOF[I] /4.38;
      UTOF[I] := UTOF[I]*5.6783;
END;
PROCEDURE ACCESS_7;
BEGIN
  { WATER/SYRUP }
      S_Q1[I]:= 7 * S_D * (1-(0.006*BR)) * DT1[I];
      Q2[I] := 7 * DT2[I];
      AVGQ:= ( ABS(S_Q1[I]) + ABS(Q2[I])) / 2;
      IF TLM[I] = 0 THEN
        U1[I]:= 0
      ELSE
        U1[I]:= (AVGQ*60* 0.001)/(NA[I]* TLM[I]);
        U2[I]:= U1[I] / 4.38;
        U3[I]:= U2[I] * 5.6783;
        VL := (V/(2*60*1.0E+06))/A;
        RE1[I]:= (DE *VL * S_D*1000)/(S_MEU1[I]*0.001);
        VL2 := ((V/2+V/3)/(2*60*1.0E+06))/A;
        RE2[I]:= (DE*VL2*P)/(MEU2[I]*0.001);
{CASE C-1 = THEORY }
      HT1[I] := (0.2*(EXP(0.67*LN(RE1[I])))*(EXP(0.4*LN(S_PR1[I])))*S_K1[I])/DE;
      HT2[I] := (0.2*(EXP(0.67*LN(RE2[I])))*(EXP(0.4*LN(PR2[I])))*K2[I])/DE;
      UT[I] := 1 / ((1/HT1[I]) + ((0.6*0.001)/14.006) + ( 1/HT2[I]));
      UT[I] := UT[I] /4.38;
      UT[I] := UT[I]*5.6783;
      NOT1[I]:= HT1[I] *DE / S_K1[I];
      NOT2[I]:= HT2[I] *DE / K2[I];
{CASE C-2 = TOTAL OPT }
      HTO1[I] := (0.02*(EXP(0.37*LN(RE1[I])))*(EXP(0.79*LN(S_PR1[I])))*S_K1[I])/DE;
      HTO2[I] := (0.02*(EXP(0.37*LN(RE2[I])))*(EXP(0.79*LN(PR2[I])))*K2[I])/DE;
      UTO[I] := 1 / ((1/HTO1[I]) + ((0.6*0.001)/14.006) + ( 1/HTO2[I]));
      UTO[I] := UTO[I] /4.88;
      UTO[I] := UTO[I]*5.6783;
{CASE C-3 = TOTAL OPT.F }
      HTOF1[I] := (0.4*(EXP(0.55*LN(RE1[I])))*(EXP(0.4*LN(S_PR1[I])))*S_K1[I])/DE;
      HTOF2[I] := (0.4*(EXP(0.55*LN(RE2[I])))*(EXP(0.4*LN(PR2[I])))*K2[I])/DE;
      UTOF[I] := 1 / ((1/HTOF1[I]) + ((0.6*0.001)/14.006) + ( 1/HTOF2[I]));
      UTOF[I] := UTOF[I] /4.38;
      UTOF[I] := UTOF[I]*5.6783;
{CASE NC-1 = Hw USE CORRELATION FROM THEORY}
      HT2[I] := (0.2*(EXP(0.67*LN(RE2[I])))*(EXP(0.4*LN(PR2[I])))*K2[I])/DE;
      H_T1[I]:= U1[I]/(1-U1[I]*(1/HT2[I]+(0.0006/14.006)));
      NO_T1[I]:= H_T1[I]*DE/S_K1[I];
      NOT2[I] := HT2[I]*DE/K2[I];
{CASE NC-2 = Hw USE CORRELATION FROM OPT.}
      HWCC2[I] := (0.006291*(EXP(0.957*LN(RE2[I])))*(EXP(1.39*LN(PR2[I])))*K2[I])/DE;
      HSCC1[I]:= U1[I]/(1-U1[I]*(1/HWCC2[I]+(0.0006/14.006)));
      NWCC1[I]:= HSCC1[I]*DE/S_K1[I];
      HWCC2[I]:= HWCC2[I]*DE/K2[I];
{CASE NC-3 = Hw USE CORRELATION FROM OPT.F}
      HWCCC2[I] := (0.17755*(EXP(0.659*LN(RE2[I])))*(EXP(0.4*LN(PR2[I])))*K2[I])/DE;
      HSCCC1[I]:= U1[I]/(1-U1[I]*(1/HWCCC2[I]+(0.0006/14.006)));
      NWCCC1[I]:= HSCCC1[I]*DE/S_K1[I];
      HWCCC2[I]:= HWCCC2[I]*DE/K2[I];

```

END;

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PROCEDURE PROCESS;

BEGIN

FOR I := 1 TO 3 DO

BEGIN

BEGIN

TB1[I] := (TIN1[I] + TOUT1[I]) / 2;

TB2[I] := (TIN2[I] + TOUT2[I]) / 2;

END;

BEGIN

MEU1[I] := (1/(2.1482*((TB1[I]-8.435)+SQRT(8078.4+((TB1[I]-8.435)*(TB1[I]-8.435))))-120))*100;

MEU2[I] := (1/(2.1482*((TB2[I]-8.435)+SQRT(8078.4+((TB2[I]-8.435)*(TB2[I]-8.435))))-120))*100;

END;

FIND_S_MEU;

ACCESS_1;

ACCESS_2;

ACCESS_3;

ACCESS_4;

DT1[I] := TOUT1[I] - TIN1[I];

DT2[I] := TOUT2[I] - TIN2[I];

IF (TIN2[I] - TOUT1[I]) / (TOUT2[I] - TIN1[I]) < 2.5 THEN

TLM[I] := ((TOUT2[I] + TIN2[I]) - (TOUT1[I] + TIN1[I])) / 2

ELSE

TLM[I] := ((TIN2[I]-TOUT1[I])-(TOUT2[I]-TIN1[I]))/LN((TIN2[I]-TOUT1[I])/(TOUT2[I]-TIN1[I]));

IF I = 1 THEN ACCESS_5;

IF I = 2 THEN ACCESS_6;

IF I = 3 THEN ACCESS_7;

END;

END;

PROCEDURE SAVE_DETAIL;

BEGIN

SS_RE_M[INDEX1+1] := RC[2];

SS_PR_M[INDEX1+1] := (S_PR1[2]+S_PR2[2])/2;

SS_NO_M[INDEX1+1] := NO[2];

SS_TPR[INDEX1+1] := (S_PR1[2]+S_PR2[2])/2; STR(SS_TPR[INDEX1+1]:22:15, ST_TPR[INDEX1+1]);

SS_TRE[INDEX1+1] := RC[2]; STR(SS_TRE[INDEX1+1]:22:15, ST_TRE[INDEX1+1]);

SS_TNO[INDEX1+1] := NO[2]; STR(SS_TNO[INDEX1+1]:22:15, ST_TNO[INDEX1+1]);

TU32[INDEX1+1] := U3[2]; STR(TU32[INDEX1+1]:22:15, TU32T[INDEX1+1]);

TUO2[INDEX1+1] := UO[2]; STR(TUO2[INDEX1+1]:22:15, TUO2T[INDEX1+1]);

TUOF2[INDEX1+1] := UOF[2]; STR(TUOF2[INDEX1+1]:22:15, TUOF2T[INDEX1+1]);

TUT2[INDEX1+1] := UT[2]; STR(TUT2[INDEX1+1]:22:15, TUT2T[INDEX1+1]);

TUTO2[INDEX1+1] := UTO[2]; STR(TUTO2[INDEX1+1]:22:15, TUTO2T[INDEX1+1]);

TUTOF2[INDEX1+1] := UTOF[2]; STR(TUTOF2[INDEX1+1]:22:15, TUTOF2T[INDEX1+1]);

RE_M[INDEX2+1] := RE2[1];

RE_M[INDEX2+2] := RE1[3];

PR_M[INDEX2+1] := S_PR2[1];

PR_M[INDEX2+2] := S_PR1[3];

NO_M[INDEX2+1] := NO_T2[1];

NO_M[INDEX2+2] := NO_T1[3];

NO_N[INDEX2+1] := NUCC2[1];

NO_N[INDEX2+2] := NUCC1[3];

NO_O[INDEX2+1] := NUCCC2[1];

NO_O[INDEX2+2] := NUCCC1[3];

NS_TPR[INDEX2+1] := S_PR2[1];

NS_TPR[INDEX2+2] := S_PR1[3];

NS_TRE[INDEX2+1] := RE2[1];

STR(NS_TPR[INDEX2+1]:22:15, NT_TPR[INDEX2+1]);

STR(NS_TPR[INDEX2+2]:22:15, NT_TPR[INDEX2+2]);

STR(NS_TRE[INDEX2+1]:22:15, NT_TRE[INDEX2+1]);

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WS_TRE[INDEX2+2]:=RE1[3];
TNUC[INDEX2+1]:=NU_T2[1];
TNUC[INDEX2+2]:=NU_T1[3];
TNUCC[INDEX2+1]:=NUCC2[1];
TNUCC[INDEX2+2]:=NUCC1[3];
TNUCCC[INDEX2+1]:=NUCCC2[1];
TNUCCC[INDEX2+2]:=NUCCC1[3];
TU313[INDEX2+1]:=U3[1];
TU313[INDEX2+2]:=U3[3];
TUT13[INDEX2+1]:=UT[1];
TUT13[INDEX2+2]:=UT[3];
TUTO13[INDEX2+1]:=UTO[1];
TUTO13[INDEX2+2]:=UTO[3];
TUTOF13[INDEX2+1]:=UTOF[1];
TUTOF13[INDEX2+2]:=UTOF[3];
INDEX1:=INDEX1+1;
INDEX2:=INDEX2+2;
STR(WS_TRE[INDEX2+2]:22:15,WT_TRE[INDEX2+2]);
STR(TNUC[INDEX2+1]:22:15,TNU_T[INDEX2+1]);
STR(TNUC[INDEX2+2]:22:15,TNU_T[INDEX2+2]);
STR(TNUCC[INDEX2+1]:22:15,TNUCT[INDEX2+1]);
STR(TNUCC[INDEX2+2]:22:15,TNUCT[INDEX2+2]);
STR(TNUCCC[INDEX2+1]:22:15,TNUCCT[INDEX2+1]);
STR(TNUCCC[INDEX2+2]:22:15,TNUCCT[INDEX2+2]);
STR(TU313[INDEX2+1]:22:15,TU313T[INDEX2+1]);
STR(TU313[INDEX2+2]:22:15,TU313T[INDEX2+2]);
STR(TUT13[INDEX2+1]:22:15,TUT13T[INDEX2+1]);
STR(TUT13[INDEX2+2]:22:15,TUT13T[INDEX2+2]);
STR(TUTO13[INDEX2+1]:22:15,TUTO13T[INDEX2+1]);
STR(TUTO13[INDEX2+2]:22:15,TUTO13T[INDEX2+2]);
STR(TUTOF13[INDEX2+1]:22:15,TUTOF13T[INDEX2+1]);
STR(TUTOF13[INDEX2+2]:22:15,TUTOF13T[INDEX2+2]);
END;
PROCEDURE SAVE_FILE;
BEGIN
  CLRESCR;
  GOTOXY(20,13);
  WRITE('PLEASE INPUT FILE NAME FOR S/S...');
  GOTOXY(52,13);
  READLN(FILE_NAME);
  ASSIGN(RR,FILE_NAME);
  REWRITE(RR);
  FOR I:=1 TO INDEX1 DO
    WRITE(RR,SS_RE_M[I]);
  FOR I:=1 TO INDEX1 DO
    WRITE(RR,SS_PR_M[I]);
  FOR I:=1 TO INDEX1 DO
    WRITE(RR,SS_NO_M[I]);
  CLOSE(RR);

  ASSIGN(P_T,'SS_PR.TXT');
  REWRITE(P_T);
  FOR I:=1 TO INDEX1 DO
    WRITELN(P_T,ST_TPR[I]);
  CLOSE(P_T);

  ASSIGN(P_T,'SS_RE.TXT');
  REWRITE(P_T);
  FOR I:=1 TO INDEX1 DO
    WRITELN(P_T,ST_TRE[I]);
  CLOSE(P_T);

  ASSIGN(P_T,'SS_NO.TXT');
  REWRITE(P_T);
  FOR I:=1 TO INDEX1 DO
    WRITELN(P_T,ST_TNO[I]);
  CLOSE(P_T);

  ASSIGN(P_T,'U32.TXT');
  REWRITE(P_T);
  FOR I:=1 TO INDEX1 DO
    WRITELN(P_T,TU32T[I]);
  CLOSE(P_T);

  ASSIGN(P_T,'U02.TXT');

```

```

REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
  WRITELN(P_T, T002T[I]);
CLOSE(P_T);

ASSIGN(P_T, 'U0F2.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
  WRITELN(P_T, T00F2T[I]);
CLOSE(P_T);

ASSIGN(P_T, 'U1T2.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
  WRITELN(P_T, T01T2T[I]);
CLOSE(P_T);

ASSIGN(P_T, 'U1O2.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
  WRITELN(P_T, T01O2T[I]);
CLOSE(P_T);

ASSIGN(P_T, 'U1OF2.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
  WRITELN(P_T, T01OF2T[I]);
CLOSE(P_T);

GOTOXY(20, 15);
WRITE('PLEASE INPUT FILENAME W/S NUT..');
GOTOXY(52, 15);
READLN(FILE_NAME);
ASSIGN(RR, FILE_NAME);
REWRITE(RR);
FOR I:=1 TO INDEX2 DO
  WRITE(RR, RE_M[I]);
FOR I:=1 TO INDEX2 DO
  WRITE(RR, PR_M[I]);
FOR I:=1 TO INDEX2 DO
  WRITE(RR, NU_M[I]);
CLOSE(RR);

GOTOXY(20, 17);
WRITE('PLEASE INPUT FILENAME W/S NUC..');
GOTOXY(52, 17);
READLN(FILE_NAME);
ASSIGN(RR, FILE_NAME);
REWRITE(RR);
FOR I:=1 TO INDEX2 DO
  WRITE(RR, RE_M[I]);
FOR I:=1 TO INDEX2 DO
  WRITE(RR, PR_M[I]);
FOR I:=1 TO INDEX2 DO
  WRITE(RR, NU_N[I]);
CLOSE(RR);

GOTOXY(20, 19);
WRITE('PLEASE INPUT FILENAME W/S NUCC..');
GOTOXY(52, 19);

```



```

READLN(FILE_NAME);
ASSIGN(RR, FILE_NAME);
REWRITE(RR);
FOR I:=1 TO INDEX2 DO
  WRITE(RR, RE_M[I]);
FOR I:=1 TO INDEX2 DO
  WRITE(RR, PR_M[I]);
FOR I:=1 TO INDEX2 DO
  WRITE(RR, NU_O[I]);
CLOSE(RR);

```

```

ASSIGN(P_T, 'WS_PR.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
  WRITELN(P_T, WT_TPR[I]);
CLOSE(P_T);

```

```

ASSIGN(P_T, 'WS_RE.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
  WRITELN(P_T, WT_PRE[I]);
CLOSE(P_T);

```

```

ASSIGN(P_T, 'PNUC.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
  WRITELN(P_T, PNOT[I]);
CLOSE(P_T);

```

```

ASSIGN(P_T, 'PNUCC.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
  WRITELN(P_T, PNUCT[I]);
CLOSE(P_T);

```

```

ASSIGN(P_T, 'PNUCCC.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
  WRITELN(P_T, PNUCCT[I]);
CLOSE(P_T);

```

```

ASSIGN(P_T, 'U313.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
  WRITELN(P_T, U313T[I]);
CLOSE(P_T);

```

```

ASSIGN(P_T, 'U713.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
  WRITELN(P_T, U713T[I]);
CLOSE(P_T);

```

```

ASSIGN(P_T, 'U7013.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
  WRITELN(P_T, U7013T[I]);
CLOSE(P_T);

```

```

ASSIGN(P_T, 'U70F13.TXT');

```



```

REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
  WRITELN(P_T, TOTOFIST[I]);
CLOSE(P_T);
END;
BEGIN(MAIN)
FOR I:= 1 TO 200 DO
  RE_M[I]:= 0;
INDEX1 :=0;
INDEX2 :=0;
NA[1] := 0.55;
NA[2] := 1.75;
NA[3] := 0.4;
AA := 0.05;
DE := 6.26 * 0.001;
A := 11.25 * 0.0001 * 0.313;
P := 1000;
L := 44.5 * 0.01;
LINES:= '-----';
BEGIN
  REPEAT
    BEGIN
      START;
      PROCESS;
      GOTOXY(14,24); WRITE('ARE YOU SURE TO SAVE (Y/N) ? ');
      READ(KEY,PP);
      IF UPCASE(PP) = 'Y' THEN SAVE_DETAIL;
      GOTOXY(14,24); WRITE('DO YOU WANT TO TEST (Y/N) ? ');
      READ(KEY,PP);
    END;
  UNTIL UPCASE(PP) = 'N';
END;
SAVE_FILE;
END.

```



```

PROGRAM 5
TYPE FIVARR = FILE OF REAL;
      FIVART = TEXT;
VAR F, F1, F2, B, BT, BT1, BT2, B_T1, B_T2, BW1, BW2, B_W1, B_W2 : ARRAY[1..3] OF REAL;
    K1, K2, MEU1, MEU2, G_MEU1, G_MEU2, BC, B_S1, B_S2 : ARRAY[1..3] OF REAL;
    O1, O2, O3, OT, DT1, DT2, TIN1, TIN2, TOUT1, TOUT2, BG1, BG2 : ARRAY[1..3] OF REAL;
    PR1, PR2, G_PR1, G_PR2, Q1, Q2, G_Q1, G_Q2, B_G1, B_G2 : ARRAY[1..3] OF REAL;
    TLM, TB1, TB2, RE1, RE2, NA, RC, BGCCC1, BGCCC2, BWCC1, BWCC2 : ARRAY[1..3] OF REAL;
    BGCC1, BGCC2, NU, NU_1, NU_2, NUT1, NUT2, NUT, NU_T1, NU_T2 : ARRAY[1..3] OF REAL;
    NUCC1, NUCC2, NUCCC1, NUCCC2, BWCC1, BWCC2, BTO1, BTO2 : ARRAY[1..3] OF REAL;
    BO1, BO2, BOF1, BOF2, BTOF1, BTOF2, BTO, BTOF, BO, BOF : ARRAY[1..3] OF REAL;
    AVGQ, DE, JA, A, P, VG, CP, MO, AS, BS, G_D, G_K, L, Y, VL, VL2, WJ, XJ : REAL;
    RE_M2, PR_M2, NU_M2, RE_M13, PR_M13, NU_M13, NU_M13, NU_O13 : ARRAY[1..200] OF REAL;
    TPR2, TRE2, TNU2, TPR13, TRE13, TNUC13, TNUCC13, TNUCCC13 : ARRAY[1..100] OF REAL;
    TU32, TUC2, TUCC2, TUT2, TUO2, TUOF2, TUTO2, TUTOF2 : ARRAY[1..100] OF REAL;
    TU313, TUT13, TUTO13, TUTOF13 : ARRAY[1..100] OF REAL;
    TPR2T, TRE2T, TNU2T : ARRAY[1..50] OF STRING[22];
    TPR13T, TRE13T, TNUC13T, TNUCC13T, TNUCCC13T : ARRAY[1..100] OF STRING[22];
    TU32T, TUT2T, TUO2T, TUOF2T, TUTO2T, TUTOF2T : ARRAY[1..50] OF STRING[22];
    TU313T, TUT13T, TUTO13T, TUTOF13T : ARRAY[1..100] OF STRING[22];
    I, J, RES, INDEX1, INDEX2 : INTEGER;
    LINE55 : STRING[20];
    PP, CAS, P1 : CHAR;
    XX : STRING[2];
    FILE_NAME : STRING[15];
    RR : FIVARR;
    P_T : FIVART;
    PNUC, PNUCC, PNUCCC, N_CC, N_CCC : FIVART;
FUNCTION G_VOP(O1, O2, O3: REAL) : REAL;
BEGIN
  G_VOP := (O1*O2)/O3;
END;
FUNCTION VOK(X1, X2, X3, X4, X5: REAL) : REAL;
BEGIN
  VOK := (((X1-X2)*X3)/X4)+X5;
END;
FUNCTION VOP(Y1, Y2, Y3, Y4, Y5: REAL) : REAL;
BEGIN
  VOP := Y5-(((Y1-Y2)*Y3)/Y4);
END;
PROCEDURE START;
LABEL AGAIN;
VAR OK : CHAR;
BEGIN
  AGAIN:
    CLRSCL;
    GOTOXY(17, 5);
    WRITE(LINE55);
    GOTOXY(24, 6); WRITE('Tin');
    GOTOXY(31, 6); WRITE('Tout');
    GOTOXY(17, 7); WRITE(LINE55);
    GOTOXY(20, 8); WRITE('1');
    GOTOXY(17, 9); WRITE('3');
    GOTOXY(20, 10); WRITE('2');
    GOTOXY(17, 11); WRITE(LINE55);
    GOTOXY(20, 12); WRITE('1');
    GOTOXY(17, 13); WRITE('1');
    GOTOXY(20, 14); WRITE('2');
    GOTOXY(17, 15); WRITE(LINE55);
    GOTOXY(20, 16); WRITE('1');

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GOTOXY(17,17); WRITE('2');
GOTOXY(20,18); WRITE('2');
GOTOXY(17,19); WRITE(LINE55);
GOTOXY(15,1); WRITE('DENSITY OF GLYCERINE = ');
READLN(G_D);
GOTOXY(38,1);
WRITE(G_D:9:6);
GOTOXY(15,3);
WRITE('THE VALUE OF V = ');
READLN (V);
GOTOXY(32,3);
WRITE(V:7:2);
GOTOXY(15,21); WRITE('Volume of glycerine = ');
READLN (VG);
GOTOXY(37,21);
WRITE(VG:6:2);
GOTOXY(15,23); WRITE('G_MEU,slope = ');
READLN (AS);
GOTOXY(29,23);
WRITE(AS:9:4);
GOTOXY(43,23); WRITE(':intercept = ');
READLN (BS);
GOTOXY(56,23);
WRITE(BS:10:5);
FOR I:= 1 TO 3 DO
  BEGIN
    GOTOXY(24,(I*2)+I*2+4); READLN(TIN1[I]);
    GOTOXY(24,(I*2)+I*2+4); WRITE(TIN1[I]:5:2);
    GOTOXY(24,(I*2)+I*2+6); READLN(TIN2[I]);
    GOTOXY(24,(I*2)+I*2+6); WRITE(TIN2[I]:5:2);
  END;
FOR I:= 1 TO 3 DO
  BEGIN
    GOTOXY(31,(I*2)+I*2+4); READLN(TOUT1[I]);
    GOTOXY(31,(I*2)+I*2+4); WRITE(TOUT1[I]:5:2);
    GOTOXY(31,(I*2)+I*2+6); READLN(TOUT2[I]);
    GOTOXY(31,(I*2)+I*2+6); WRITE(TOUT2[I]:5:2);
  END;
GOTOXY(20,24);
WRITE('ARE YOU SURE IN THIS DATA...(Y/N)....');
REPEAT
  GOTOXY(60,24);
  READ(KBD,OK);
  IF UPCASE(OK) = 'N' THEN
    GOTO AGAIN;
UNTIL UPCASE(OK) IN ['Y','N'];
END;
PROCEDURE FIND_MOLE;
BEGIN
  MO:=(100*(VG*G_D)/92.09)/(((VG*G_D)/92.09)+(40/18));
END;
PROCEDURE FIND_CP;
BEGIN
  CP:=(-0.00369*MO)+0.902119;
END;
PROCEDURE FIND_G_K;
BEGIN
  IF VG=60 THEN G_K:= 5.32739613;
  IF VG=50 THEN G_K:= 5.356415347;

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IF VG=40 THEN G_K:= 0.385434565;
END;
PROCEDURE FIND_G_MEU;
BEGIN
  BEGIN
    G_MEU1[I]:= EXP(((AS/(TB1[I]+273)) + BS)*LN(10));
    G_MEU2[I]:= EXP(((AS/(TB2[I]+273)) + BS)*LN(10));
  END;
END;
PROCEDURE ACCESS_1;
BEGIN
  IF TB1[I] < 26.68 THEN
    CAS:= 'A'
  ELSE
    IF TB1[I] < 32.23 THEN
      CAS:= '1'
    ELSE
      IF TB1[I] < 37.79 THEN
        CAS:= '2'
      ELSE
        IF TB1[I] < 48.9 THEN
          CAS:= '3'
        ELSE
          IF TB1[I] < 60.01 THEN
            CAS:= '4'
          ELSE
            IF TB1[I] < 71.12 THEN
              CAS:= '5'
            ELSE
              IF TB1[I] < 82.23 THEN
                CAS:= '6'
              ELSE
                IF TB1[I] < 93.34 THEN
                  CAS:= '7'
                ELSE
                  CAS:= '8';
        CASE CAS OF
          'A' : BEGIN
            K1[I] := VOK(TB1[I],21.11,0.006,5.56,0.345)*1.49;
            PR1[I]:= VOP(TB1[I],21.11,0.91,5.56,6.83);
            G_PR1[I]:= G_VOP(CP,G_MEU1[I],G_K)*3.6;
          END;
          '1' : BEGIN
            K1[I] := VOK(TB1[I],26.67,0.006,5.55,0.351)*1.49;
            PR1[I]:= VOP(TB1[I],26.67,0.74,5.55,5.92);
            G_PR1[I]:= G_VOP(CP,G_MEU1[I],G_K)*3.6;
          END;
          '2' : BEGIN
            K1[I] := VOK(TB1[I],32.22,0.006,5.56,0.357)*1.49;
            PR1[I]:= VOP(TB1[I],32.22,0.61,5.56,5.18);
            G_PR1[I]:= G_VOP(CP,G_MEU1[I],G_K)*3.6;
          END;
          '3' : BEGIN
            K1[I] := VOK(TB1[I],37.78,0.009,11.11,0.363)*1.49;
            PR1[I]:= VOP(TB1[I],37.78,0.92,11.11,4.57);
            G_PR1[I]:= G_VOP(CP,G_MEU1[I],G_K)*3.6;
          END;
          '4' : BEGIN
            K1[I] := VOK(TB1[I],48.89,0.007,11.11,0.372)*1.49;
            PR1[I]:= VOP(TB1[I],48.89,0.64,11.11,3.65);

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      G_PR1[I] := G_VOP(CP, G_MED1[I], G_K) * 3.6;
    END;
'5' : BEGIN
      K1[I] := VOK(TB1[I], 60.0, 0.006, 11.11, 0.379) * 1.49;
      PR1[I] := VOP(TB1[I], 60.0, 0.49, 11.11, 3.01);
      G_PR1[I] := G_VOP(CP, G_MED1[I], G_K) * 3.6;
    END;
'6' : BEGIN
      K1[I] := VOK(TB1[I], 71.11, 0.005, 11.11, 0.385) * 1.49;
      PR1[I] := VOP(TB1[I], 71.11, 0.36, 11.11, 2.52);
      G_PR1[I] := G_VOP(CP, G_MED1[I], G_K) * 3.6;
    END;
'7' : BEGIN
      K1[I] := VOK(TB1[I], 82.22, 0.003, 11.11, 0.390) * 1.49;
      PR1[I] := VOP(TB1[I], 82.22, 0.27, 11.11, 2.16);
      G_PR1[I] := G_VOP(CP, G_MED1[I], G_K) * 3.6;
    END;
'8' : BEGIN
      K1[I] := VOK(TB1[I], 93.33, 0.002, 11.11, 0.393) * 1.49;
      PR1[I] := VOP(TB1[I], 93.33, 0.227, 11.11, 1.89);
      G_PR1[I] := G_VOP(CP, G_MED1[I], G_K) * 3.6;
    END;
  END;
END;
PROCEDURE ACCESS_2;
BEGIN
  IF TB2[I] < 26.68 THEN
    CAS := 'A'
  ELSE
    IF TB2[I] < 32.23 THEN
      CAS := '1'
    ELSE
      IF TB2[I] < 37.79 THEN
        CAS := '2'
      ELSE
        IF TB2[I] < 48.9 THEN
          CAS := '3'
        ELSE
          IF TB2[I] < 60.01 THEN
            CAS := '4'
          ELSE
            IF TB2[I] < 71.12 THEN
              CAS := '5'
            ELSE
              IF TB2[I] < 82.23 THEN
                CAS := '6'
              ELSE
                IF TB2[I] < 93.34 THEN
                  CAS := '7'
                ELSE
                  CAS := '8';
        CASE CAS OF
          'A' : BEGIN
            K2[I] := VOK(TB2[I], 21.11, 0.006, 5.56, 0.345) * 1.49;
            PR2[I] := VOP(TB2[I], 21.11, 0.91, 5.56, 6.83);
            G_PR2[I] := G_VOP(CP, G_MED2[I], G_K) * 3.6;
          END;
          '1' : BEGIN
            K2[I] := VOK(TB2[I], 26.67, 0.006, 5.55, 0.351) * 1.49;
            PR2[I] := VOP(TB2[I], 26.67, 0.74, 5.55, 5.92);

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        G_PR2[I]:= G_VOP(CP,G_MED2[I],G_K)*3.6;
    END;
'2' : BEGIN
    K2[I] := VOK(TB2[I],32.22,0.006,5.56,0.357)*1.49;
    PR2[I]:= VOP(TB2[I],32.22,0.61,5.56,5.18);
    G_PR2[I]:= G_VOP(CP,G_MED2[I],G_K)*3.6;
    END;
'3' : BEGIN
    K2[I] := VOK(TB2[I],37.78,0.009,11.11,0.363)*1.49;
    PR2[I]:= VOP(TB2[I],37.78,0.92,11.11,4.57);
    G_PR2[I]:= G_VOP(CP,G_MED2[I],G_K)*3.6;
    END;
'4' : BEGIN
    K2[I] := VOK(TB2[I],48.39,0.007,11.11,0.372)*1.49;
    PR2[I]:= VOP(TB2[I],48.39,0.64,11.11,3.65);
    G_PR2[I]:= G_VOP(CP,G_MED2[I],G_K)*3.6;
    END;
'5' : BEGIN
    K2[I] := VOK(TB2[I],60.0,0.006,11.11,0.379)*1.49;
    PR2[I]:= VOP(TB2[I],60.0,0.49,11.11,3.01);
    G_PR2[I]:= G_VOP(CP,G_MED2[I],G_K)*3.6;
    END;
'6' : BEGIN
    K2[I] := VOK(TB2[I],71.11,0.005,11.11,0.385)*1.49;
    PR2[I]:= VOP(TB2[I],71.11,0.36,11.11,2.52);
    G_PR2[I]:= G_VOP(CP,G_MED2[I],G_K)*3.6;
    END;
'7' : BEGIN
    K2[I] := VOK(TB2[I],82.22,0.003,11.11,0.390)*1.49;
    PR2[I]:= VOP(TB2[I],82.22,0.27,11.11,2.16);
    G_PR2[I]:= G_VOP(CP,G_MED2[I],G_K)*3.6;
    END;
'8' : BEGIN
    K2[I] := VOK(TB2[I],93.33,0.002,11.11,0.393)*1.49;
    PR2[I]:= VOP(TB2[I],93.33,0.227,11.11,1.89);
    G_PR2[I]:= G_VOP(CP,G_MED2[I],G_K)*3.6;
    END;
END;
END;
PROCEDURE ACCESS_3;
BEGIN
    { WATER/GLYCERINE }
    Q1[I] := V * DT1[I];
    G_Q2[I]:= V * G_D * CP * DT2[I];
    AVGQ := ( ABS(Q1[I]) + ABS(G_Q2[I]))/2;
    IF TLM[I] = 0 THEN
        U1[I]:= 0
    ELSE
        U1[I]:= (AVGQ*60* 0.001)/(NA[I]* TLM[I]);
    U2[I]:= U1[I] / 4.88;
    U3[I]:= U2[I] * 5.6783;
    VL := (V/(2*60*1.0E+06))/A;
    RE1[I]:= (DE *VL *P)/(MED1[I]*0.001);
    RE2[I]:= (DE*VL*G_D*1000)/(G_MED2[I]*0.001);
{CASE C-1 = THEORY}
    BT1[I] := (0.2*(EXP(0.87*LN(RE1[I])))*(EXP(0.4*LN(PR1[I])))) * K1[I])/DE;
    BT2[I] := (0.2*(EXP(0.87*LN(RE2[I])))*(EXP(0.4*LN(G_PR2[I])))) * G_K)/DE;
    UT[I] := 1 / ((1/BT1[I]) + ((0.6*0.001)/14.006) + ( 1, BT2[I]));
    OT[I] := UT[I] / 4.88;
    OT[I] := OT[I]*5.6783;

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      NOT1[I]:= BT1[I] *DE / K1[I];
      NOT2[I]:= BT2[I] *DE / G_K;
(CASE C-2 = TOTAL OPT.)
      HTO1[I] := (0.08*(EXP(0.75*LN(RE1[I])))*(EXP(0.57*LN(PRI1[I])) * K1[I])/DE;
      HTO2[I] := (0.08*(EXP(0.75*LN(RE2[I])))*(EXP(0.57*LN(G_PR2[I])) * G_K)/DE;
      OTO[I] := 1 / ((1/HTO1[I]) + ((0.6*0.001)/14.006) + ( 1/HTO2[I]));
      UTO[I] := OTO[I] / 4.88;
      BTO[I] := UTO[I]*5.6783;
(CASE C-3 = TOTAL OPT.F)
      HTOF1[I] := (0.33*(EXP(0.66*LN(RE1[I])))*(EXP(0.4*LN(PRI1[I])) * K1[I])/DE;
      HTOF2[I] := (0.33*(EXP(0.66*LN(RE2[I])))*(EXP(0.4*LN(G_PR2[I])) * G_K)/DE;
      OTOF[I] := 1 / ((1/HTOF1[I]) + ((0.6*0.001)/14.006) + ( 1/HTOF2[I]));
      UTOF[I] := OTOF[I] / 4.88;
      BTOF[I] := UTOF[I]*5.6783;
(CASE NC-1 = Ew USE CORRELATION FROM THEORY )
      HT1[I] := (0.2*(EXP(0.67*LN(RE1[I]))*(EXP(0.4*LN(PRI1[I])) * K1[I])/DE;
      HT2[I]:= O1[I]/(1-O1[I]*(1/HT1[I]+(0.006/14.006)));
      NOT1[I]:= HT1[I] *DE / K1[I];
      NOT2[I]:= HT2[I] *DE / G_K;
(CASE NC-2 = Ew USE CORRELATION FROM OPT.F)
      HNC01[I]:= (0.006281*(EXP(0.6570*LN(RE1[I]))*(EXP(1.38*LN(PRI1[I]))*K1[I])/DE;
      HNC02[I]:= O1[I]/(1-O1[I]*(1/HNC01[I]+(0.006/14.006)));
      NOCC1[I]:= HNC01[I] * DE / K1[I];
      NOCC2[I]:= HNC02[I] * DE / G_K;
(CASE NC-3 = Ew USE CORRELATION FROM OPT.F)
      HNC001[I]:= (0.17755*(EXP(0.6590*LN(RE1[I]))*(EXP(0.4*LN(PRI1[I]))*K1[I])/DE;
      HNC002[I]:= O1[I]/(1-O1[I]*(1/HNC001[I]+(0.006/14.006)));
      NOCCC1[I]:= HNC001[I] * DE / K1[I];
      NOCCC2[I]:= HNC002[I] * DE / G_K;
END;
PROCEDURE ACCESS_4;
BEGIN
  ( GLYCERINE/GLYCERINE )
  G_Q1[I]:= V * G_D * CP * DT1[I];
  G_Q2[I]:= V * G_D * CP * DT2[I];
  AVGQ := ( ABS(G_Q1[I]) + ABS(G_Q2[I])) / 2;
  IF TLM[I] = 0 THEN
    O1[I]:= 0
  ELSE
    O1[I]:= (AVGQ*60* 0.001)/(NA[I]* TLM[I]);
    O2[I]:= O1[I] / 4.88;
    O3[I]:= O2[I] * 5.6783;
    B[I] := (2*O1[I])/(1-(O1[I]*((0.6*0.001)/14.006)));
    VL := (V/(2*60*1.0E+06))/A;
    RE1[I]:= (DE*VL*G_D*1000)/(G_MED1[I]*0.001);
    RE2[I]:= (DE*VL*G_D*1000)/(G_MED2[I]*0.001);
    RC[I] := (RE1[I] +RE2[I])/2;
(CASE C = EXP.)
    H[I]:= (2*O1[I])/(1-(O1[I]*((0.6*0.001)/14.006)));
    NU[I]:= ( H[I] * DE) /G_K;
(CASE C-1 = THEORY )
    HT1[I] := (0.2*(EXP(0.67*LN(RE1[I]))*(EXP(0.4*LN(G_PR1[I])) * G_K)/DE;
    HT2[I] := (0.2*(EXP(0.67*LN(RE2[I]))*(EXP(0.4*LN(G_PR2[I])) * G_K)/DE;
    OT1[I] := 1 / ((1/HT1[I]) + ((0.6*0.001)/14.006) + ( 1/HT2[I]));
    UT1[I] := OT1[I] / 4.88;
    B1[I] := UT1[I]*5.6783;
    HT[I]:= (HT1[I]+HT2[I])/2;
    NOT[I]:= HT[I] *DE / G_K;
(CASE C-2 = GLYCERINE OPT.)
    BO1[I] := (0.08*(EXP(0.75*LN(RE1[I]))*(EXP(0.57*LN(G_PR1[I])) * G_K)/DE;

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HO2[I] := (0.08*(EXP(0.75*LN(RE2[I])))*(EXP(0.57*LN(G_PR2[I])))) * G_K/DE;
BO[I] := 1 / ((1/BO1[I]) + ((0.6*0.001)/14.006) + (1/HC2[I]));
BO[I] := BO[I] /4.88;
BO[I] := BO[I]*5.6783;
{CASE C-3 = GLYCERINE OPT.F}
BOF1[I] := (0.23*(EXP(0.66*LN(RE1[I])))*(EXP(0.4*LN(G_PR1[I])))) * G_K/DE;
BOF2[I] := (0.23*(EXP(0.66*LN(RE2[I])))*(EXP(0.4*LN(G_PR2[I])))) * G_K/DE;
BOF[I] := 1 / ((1/BOF1[I]) + ((0.6*0.001)/14.006) + (1/BOF2[I]));
BOF[I] := BOF[I] /4.88;
BOF[I] := BOF[I]*5.6783;
{CASE C-4 = GLYCERINE TOPT.}
HTO1[I] := (0.02*(EXP(0.87*LN(RE1[I])))*(EXP(0.78*LN(G_FR1[I])))) * G_K/DE;
HTO2[I] := (0.02*(EXP(0.87*LN(RE2[I])))*(EXP(0.78*LN(G_FR2[I])))) * G_K/DE;
HTO[I] := 1 / ((1/HTO1[I]) + ((0.6*0.001)/14.006) + (1/HTO2[I]));
HTO[I] := HTO[I] /4.88;
HTO[I] := HTO[I]*5.6783;
{CASE C-5 = GLYCERINE TOPT.F}
HTOF1[I] := (0.4*(EXP(0.55*LN(RE1[I])))*(EXP(0.4*LN(G_PR1[I])))) * G_K/DE;
HTOF2[I] := (0.4*(EXP(0.55*LN(RE2[I])))*(EXP(0.4*LN(G_PR2[I])))) * G_K/DE;
HTOF[I] := 1 / ((1/HTOF1[I]) + ((0.6*0.001)/14.006) + (1/HTOF2[I]));
HTOF[I] := HTOF[I] /4.88;
HTOF[I] := HTOF[I]*5.6783;
END;
PROCEDURE ACCESS_5;
BEGIN
  { WATER/GLYCERINE }
  G_Q1[I] := V * G_D * CP * DT1[I];
  Q2[I] := V * DT2[I];
  AVGQ := ( ABS(G_Q1[I]) + ABS(Q2[I]) ) / 2;
  IF TLM[I] = 0 THEN
    Q1[I] := 0
  ELSE
    Q1[I] := (AVGQ*60* 0.001)/(NA[I]* TLM[I]);
    Q2[I] := Q1[I] / 4.88;
    Q3[I] := Q2[I] * 5.6783;
    VL := (V/(2*60*1.0E+06))/A;
    RE1[I] := (DE *VL * G_D*1000)/(G_MED1[I]*0.001);
    VL2 := ((V/2+V/3)/(2*60*1.0E+06))/A;
    RE2[I] := (DE*VL2*P)/(MED2[I]*0.001);
  {CASE C-1 = THEORY }
  HT1[I] := (0.2*(EXP(0.67*LN(RE1[I])))*(EXP(0.4*LN(G_PR1[I])))) * G_K/DE;
  HT2[I] := (0.2*(EXP(0.67*LN(RE2[I])))*(EXP(0.4*LN(G_PR2[I])))) * K2[I]/DE;
  HT[I] := 1 / ((1/HT1[I]) + ((0.6*0.001)/14.006) + (1/HT2[I]));
  HT[I] := HT[I] /4.88;
  HT[I] := HT[I]*5.6783;
  NHT1[I] := HT1[I] *DE / G_K;
  NHT2[I] := HT2[I] *DE / K2[I];
  {CASE C-2 = TOTAL OPT.}
  HTO1[I] := (0.02*(EXP(0.87*LN(RE1[I])))*(EXP(0.78*LN(G_FR1[I])))) * G_K/DE;
  HTO2[I] := (0.02*(EXP(0.87*LN(RE2[I])))*(EXP(0.78*LN(G_FR2[I])))) * K2[I]/DE;
  HTO[I] := 1 / ((1/HTO1[I]) + ((0.6*0.001)/14.006) + (1/HTO2[I]));
  HTO[I] := HTO[I] /4.88;
  HTO[I] := HTO[I]*5.6783;
  {CASE C-3 = TOTAL OPT.F}
  HTOF1[I] := (0.4*(EXP(0.55*LN(RE1[I])))*(EXP(0.4*LN(G_PR1[I])))) * G_K/DE;
  HTOF2[I] := (0.4*(EXP(0.55*LN(RE2[I])))*(EXP(0.4*LN(G_PR2[I])))) * K2[I]/DE;
  HTOF[I] := 1 / ((1/HTOF1[I]) + ((0.6*0.001)/14.006) + (1/HTOF2[I]));
  HTOF[I] := HTOF[I] /4.88;
  HTOF[I] := HTOF[I]*5.6783;
  {CASE NC-1 = Eq USE CORRELATION FROM THEORY }

```



```

RT2[I] := (0.2*(EXP(0.67*LN(RE2[I])))*(EXP(0.4*LN(PR2[I]))) * K2[I])/DE;
E_T1[I] := U1[I]/(1-U1[I]*(1/RT2[I]+(0.0006/14.006)));
NU_T1[I] := E_T1[I] *DE / G_K;
TOT2[I] := RT2[I] *DE / K2[I];
(CASE NC_2 = 3 USE CORRELATION FROM OPT.1)
HWCC2[I] := (0.006231*(EXP(0.9570*LN(RE2[I])))*(EXP(1.38*LN(PR2[I]))) *K2[I])/DE;
HGCC1[I] := U1[I]/(1-U1[I]*(1/HWCC2[I]+(0.0006/14.006)));
NWCC1[I] := HGCC1[I] * DE / G_K;
WCC2[I] := HWCC2[I] * DE / K2[I];
(CASE NC_3 = 4 USE CORRELATION FROM OPT.2)
HWCC2[I] := (0.17755*(EXP(0.6590*LN(RE2[I])))*(EXP(0.4*LN(PR2[I]))) *K2[I])/DE;
HGCC1[I] := U1[I]/(1-U1[I]*(1/HWCC2[I]+(0.0006/14.006)));
NWCC1[I] := HGCC1[I] * DE / G_K;
WCC2[I] := HWCC2[I] * DE / K2[I];
END;

PROCEDURE PROCESS;
BEGIN
  FOR I := 1 TO 3 DO
    BEGIN
      BEGIN
        TB1[I] := ( TIN1[I] + TOUT1[I] ) / 2;
        TB2[I] := ( TIN2[I] + TOUT2[I] ) / 2;
      END;
      BEGIN
        MEU1[I] := (1/(2.1482*((TB1[I]-8.435)+SQRT(8078.4+((TB1[I]-8.435)*(TB1[I]-8.435))))-120))*100;
        MEU2[I] := (1/(2.1482*((TB2[I]-8.435)+SQRT(8078.4+((TB2[I]-8.435)*(TB2[I]-8.435))))-120))*100;
      END;
      FIND_MOLE;
      FIND_CP;
      FIND_G_K;
      FIND_G_MEU;
      ACCESS_1;
      ACCESS_2;
      DT1[I] := TOUT1[I] - TIN1[I];
      DT2[I] := TOUT2[I] - TIN2[I];
      IF (TIN2[I] - TOUT1[I]) / (TOUT2[I] - TIN1[I]) < 2.5 THEN
        TLM[I] := ((TOUT2[I] + TIN2[I]) - (TOUT1[I] + TIN1[I]))/2
      ELSE
        TLM[I] := ((TIN2[I]-TOUT1[I])-(TOUT2[I]-TIN1[I]))/LN((TIN2[I]-TOUT1[I]) / (TOUT2[I]-TIN1[I]));
      IF I = 1 THEN ACCESS_3;
      IF I = 2 THEN ACCESS_4;
      IF I = 3 THEN ACCESS_5;
    END;
  END;
PROCEDURE SAVE_DETAIL;
BEGIN
  RE_M2[INDEX1+1] := RC[2];
  PR_M2[INDEX1+1] := (G_PR1[2]+G_PR2[2])/2;
  NU_M2[INDEX1+1] := NU[2];
  TRE2[INDEX1+1] := RC[2]; STR(TRE2[INDEX1+1]:22:15, TRE2T[INDEX1+1]);
  TPR2[INDEX1+1] := (G_PR1[2]+G_PR2[2])/2; STR(TPR2[INDEX1+1]:22:15, TPR2T[INDEX1+1]);
  THU2[INDEX1+1] := NU[2]; STR THU2[INDEX1+1]:22:15, THU2T[INDEX1+1]);
  RE_M13[INDEX2+1] := RE2[1];
  RE_M13[INDEX2+2] := RE1[3];
  PR_M13[INDEX2+1] := G_PR2[1];
  PR_M13[INDEX2+2] := G_PR1[3];
  NU_M13[INDEX2+1] := NU_T2[1];

```

```

NU_M13{INDEX2+2}:= NU_T1{3};
NU_M13{INDEX2+1}:= NUCC2{1};
NU_M13{INDEX2+2}:= NUCC1{3};
NU_D13{INDEX2+1}:= NUCCC2{1};
NU_D13{INDEX2+2}:= NUCCC1{3};
TPR13{INDEX2+1}:= G_PR2{1};
TPR13{INDEX2+2}:= G_PR1{3};
TRE13{INDEX2+1}:= RE2{1};
TRE13{INDEX2+2}:= RE1{3};
TNUC13{INDEX2+1}:= NU_T2{1};
TNUC13{INDEX2+2}:= NU_T1{3};
TNUCC13{INDEX2+1}:= NUCC2{1};
TNUCC13{INDEX2+2}:= NUCC1{3};
TNUCCC13{INDEX2+1}:= NUCCC2{1};
TNUCCC13{INDEX2+2}:= NUCCC1{3};
TU32{INDEX1+1}:= U3{2};
TUT2{INDEX1+1}:= UT{2};
TUO2{INDEX1+1}:= UO{2};
TUOF2{INDEX1+1}:= UOF{2};
TUTO2{INDEX1+1}:= UTO{2};
TUTOF2{INDEX1+1}:= UTOF{2};
TU313{INDEX2+1}:= U3{1};
TU313{INDEX2+2}:= U3{3};
TUT13{INDEX2+1}:= UT{1};
TUT13{INDEX2+2}:= UT{3};
TUTO13{INDEX2+1}:= UTO{1};
TUTO13{INDEX2+2}:= UTO{3};
TUTOF13{INDEX2+1}:= UTOF{1};
TUTOF13{INDEX2+2}:= UTOF{3};
INDEX1:= INDEX1 +1;
INDEX2:= INDEX2 +2;
END;
PROCEDURE SAVE_FILE;
BEGIN
  CLSCR;
  GOTOXY(20,13 );
  WRITE('PLEASE INPUT FILENAME FOR G/G..');
  GOTOXY(52,13);
  READLN(FILE_NAME);
  ASSIGN(RR,FILE_NAME);
  REWRITE(RR);
  FOR I:=1 TO INDEX1 DO
    WRITE(RR,RE_M2{I});
  FOR I:=1 TO INDEX1 DO
    WRITE(RR,PR_M2{I});
  FOR I:=1 TO INDEX1 DO
    WRITE(RR,NU_M2{I});
  CLOSE(RR);
  GOTOXY(20,15 );
  WRITE('PLEASE INPUT FILENAME W/G NOT..');
  GOTOXY(52,15);
  READLN(FILE_NAME);
  ASSIGN(RR,FILE_NAME);
  REWRITE(RR);
  FOR I:=1 TO INDEX2 DO
    WRITE(RR,RE_M13{I});
  FOR I:=1 TO INDEX2 DO
    WRITE(RR,PR_M13{I});
  FOR I:=1 TO INDEX2 DO
    WRITE(RR,NU_M13{I});
  STR(TPR13{INDEX2+1}:22:15,TPR13T{INDEX2+1});
  STR(TPR13{INDEX2+2}:22:15,TPR13T{INDEX2+2});
  STR(TRE13{INDEX2+1}:22:15,TRE13T{INDEX2+1});
  STR(TRE13{INDEX2+2}:22:15,TRE13T{INDEX2+2});
  STR(TNUC13{INDEX2+1}:22:15,TNUC13T{INDEX2+1});
  STR(TNUC13{INDEX2+2}:22:15,TNUC13T{INDEX2+2});
  STR(TNUCC13{INDEX2+1}:22:15,TNUCC13T{INDEX2+1});
  STR(TNUCC13{INDEX2+2}:22:15,TNUCC13T{INDEX2+2});
  STR(TNUCCC13{INDEX2+1}:22:15,TNUCCC13T{INDEX2+1});
  STR(TNUCCC13{INDEX2+2}:22:15,TNUCCC13T{INDEX2+2});
  STR(TU32{INDEX1+1}:22:15,TU32T{INDEX1+1});
  STR(TUT2{INDEX1+1}:22:15,TUT2T{INDEX1+1});
  STR(TUO2{INDEX1+1}:22:15,TUO2T{INDEX1+1});
  STR(TUOF2{INDEX1+1}:22:15,TUOF2T{INDEX1+1});
  STR(TUTO2{INDEX1+1}:22:15,TUTO2T{INDEX1+1});
  STR(TUTOF2{INDEX1+1}:22:15,TUTOF2T{INDEX1+1});
  STR(TU313{INDEX2+1}:22:15,TU313T{INDEX2+1});
  STR(TU313{INDEX2+2}:22:15,TU313T{INDEX2+2});
  STR(TUT13{INDEX2+1}:22:15,TUT13T{INDEX2+1});
  STR(TUT13{INDEX2+2}:22:15,TUT13T{INDEX2+2});
  STR(TUTO13{INDEX2+1}:22:15,TUTO13T{INDEX2+1});
  STR(TUTO13{INDEX2+2}:22:15,TUTO13T{INDEX2+2});
  STR(TUTOF13{INDEX2+1}:22:15,TUTOF13T{INDEX2+1});
  STR(TUTOF13{INDEX2+2}:22:15,TUTOF13T{INDEX2+2});

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```

CLOSE(RR);
GOTOXY(20,17 );
WRITE('PLEASE INPUT FILENAME W/G NOC...');
GOTOXY(52,17);
READLN(FILE_NAME);
ASSIGN(RR,FILE_NAME);
REWRITE(RR);
FOR I:=1 TO INDEX2 DO
WRITE(RR,RE_M13[I]);
FOR I:=1 TO INDEX2 DO
WRITE(RR,PR_M13[I]);
FOR I:=1 TO INDEX2 DO
WRITE(RR,NU_M13[I]);
CLOSE(RR);
GOTOXY(20,19 );
WRITE('PLEASE INPUT FILENAME W/G NOCC...');
GOTOXY(52,19);
READLN(FILE_NAME);
ASSIGN(RR,FILE_NAME);
REWRITE(RR);
FOR I:=1 TO INDEX2 DO
WRITE(RR,RE_M13[I]);
FOR I:=1 TO INDEX2 DO
WRITE(RR,PR_M13[I]);
FOR I:=1 TO INDEX2 DO
WRITE(RR,NU_M13[I]);
CLOSE(RR);

ASSIGN(P_T,'GG_PR.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
WRITELN(P_T,7PR2T[I]);
CLOSE(P_T);
ASSIGN(P_T,'GG_RE.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
WRITELN(P_T,7RE2T[I]);
CLOSE(P_T);
ASSIGN(P_T,'GG_NU.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
WRITELN(P_T,7NU2T[I]);
CLOSE(P_T);
ASSIGN(P_T,'NGPR.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
WRITELN(P_T,7PR13T[I]);
CLOSE(P_T);
ASSIGN(P_T,'NGRE.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
WRITELN(P_T,7RE13T[I]);
CLOSE(P_T);
ASSIGN(P_T,'NGNOC.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
WRITELN(P_T,7NOC13T[I]);
CLOSE(P_T);
ASSIGN(P_T,'NGNUCC.TXT');
REWRITE(P_T);

```

```

FOR I:=1 TO INDEX2 DO
WRITELN(P_T, TNUCC13T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'NGNUCC.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
WRITELN(P_T, TNUCC13T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'U3.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
WRITELN(P_T, TU32T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'UT.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
WRITELN(P_T, TUT2T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'UO.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
WRITELN(P_T, TUO2T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'UOF.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
WRITELN(P_T, TUOF2T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'UTO.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
WRITELN(P_T, TUTO2T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'UOTOF.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX1 DO
WRITELN(P_T, TUTOF2T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'U313.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
WRITELN(P_T, TU313T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'UT13.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
WRITELN(P_T, TUT13T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'UTO13.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
WRITELN(P_T, TUTO13T[I]);
CLOSE(P_T);
ASSIGN(P_T, 'UOTOF13.TXT');
REWRITE(P_T);
FOR I:=1 TO INDEX2 DO
WRITELN(P_T, TUTOF13T[I]);
CLOSE(P_T);

```

```

END;
BEGIN{MAIN}

```

```
INDEX1:=0;
INDEX2:=0;
NA[1] := 0.55;
NA[2] := 1.75;
NA[3] := 0.4;
AA := 0.05;
DE := 6.26 * 0.001;
A := 11.25 * 0.0001 * 0.313;
P := 1000;
L := 44.5 * 0.01;
LINE55:= '-----';
BEGIN
  REPEAT
    BEGIN
      START;
      PROCESS;
      GOTOXY(14,24); WRITE('ARE YOU SURE TO SAVE (Y/N) ? ');
      READ(KBD,PP);
      IF UPCASE(PP) = 'Y' THEN SAVE_DETAIL;
      GOTOXY(14,24); WRITE('DO YOU WANT TO TEST (Y/N) ? ');
      READ(KBD,PP);
    END;
  UNTIL UPCASE(PP) = 'N';
END;
SAVE_FILE;
END.
```

```

Program 6
DEFDBL A,B,C,E,F,G,H,K,L,M,N,R,S,W,X,T,Q,J
DIM A1(1),AP(1),XP(1),WP(1),GP(1),FH(1),FC(1),WH(1),WC(1)
DIM TIH(1),TOH(1),TAH(1),TIC(1),TOC(1),TAC(1),KH(1),KC(1)
DIM MMH(2),MMC(2),LP(1),FH1(1),FC1(1)
DIM SH(1),SC(1),CPH(1),CPC(1),Q(1),CMIN(1),CMAX(1),E(1)
DIM R(1),REC(1),REH(1),HH(1),HC(1),UAV(1),BR(1),AAS(1)
DIM BS(1),MO(1),NTU(1),NTU1(1),NTU2(1),N(1),PC(1),PH(1)
DIM W(5)
DIM AS(1),BS(1),CS(1),DS(1),WCS(20),WHS(20)
DIM N1S(8),N2S(8)
N1S(1)="WATER"
N1S(2)="SYRUP 20 wt%"
N1S(3)="SYRUP 30 wt%"
N1S(4)="SYRUP 40 wt%"
N1S(5)="GLYCERINE 40 vol% "
N1S(6)="GLYCERINE 50 vol%"
N1S(7)="GLYCERINE 60 vol%"
FOR I = 1 TO 7
    N2S(I) = N1S(I)
NEXT I
START:
CLS
Locate 1,1 : PRINT CHR$(201);
FOR I = 1 TO 77
    PRINT CHR$(205);
NEXT I
PRINT CHR$(187);
FOR I = 2 TO 23
    LOCATE I,1
    PRINT CHR$(186);
    LOCATE I,79
    PRINT CHR$(186);
NEXT I
LOCATE 24,1 : PRINT CHR$(200);
FOR I = 1 TO 77
    PRINT CHR$(205);
NEXT I
PRINT CHR$(188);
LOCATE 18,1 : PRINT CHR$(204);
FOR I = 1 TO 77
    PRINT CHR$(205);
NEXT I
PRINT CHR$(185);
Locate 24,24 : PRINT " ";
CLS
Locate 1,3 : PRINT "Design procedure : ";
Locate 2,3 : PRINT "SELECT THE CODE NUMBER OF THE HOT LIQUID ..(1-8).. ";
Locate 3,3 : PRINT "SELECT THE CODE NUMBER OF THE COLD LIQUID..(1-8).. ";
Locate 4,10 : PRINT "(1) : WATER";
Locate 5,10 : PRINT "(2) : SYRUP (SUCROSE SOLUTION 20 wt%)";
Locate 6,10 : PRINT "(3) : SYRUP (SUCROSE SOLUTION 30 wt%) ";
Locate 7,10 : PRINT "(4) : SYRUP (SUCROSE SOLUTION 40 wt%) ";
Locate 8,10 : PRINT "(5) : GLYCERINE 40 vol%";
Locate 9,10 : PRINT "(6) : GLYCERINE 50 vol%";
Locate 10,10 : PRINT "(7) : GLYCERINE 60 vol%";
Locate 11,10 : PRINT "(8) : OTHERS";
A100:
    Locate 2,55 : PRINT "_";
    Locate 2,55
    AS = INKEYS
    IF AS>"0" AND AS<"9" THEN
        GOTO A200
    ELSE

```

```

        GOTO A100
    END IF
A200:
    locate 2,55 : print AS:
    locate 3,55 : print "_":
    locate 3,55
    BS = INKEYS
    IF BS<"0" AND BS<"9" THEN
        GOTO A210
    ELSE
        GOTO A200
    END IF
A210:
    locate 3,55 : PRINT BS:
    FOR I = 4 TO 11
        locate i,10 : print "
    NEXT I
A220:
    locate 4,5 : PRINT "THE UNKNOWN OUTLET TEMPERATURE SIDE IS H=HOT OR C=COOL ";
    locate 4,60 : PRINT "_":
    locate 4,60
    CS = INKEYS
    IF CS="h" THEN
        CS="H"
    END IF
    IF CS="c" THEN
        CS="C"
    END IF
    IF CS<>"H" AND CS<>"C" THEN
        GOTO A220
    END IF
A250:
    locate 4,60 : PRINT CS:
    IF AS = "8" THEN
        LOCATE 5,5
        PRINT "NAME OF HOT LIQUID ";
        INPUT N1S(8)
    END IF
    IF BS = "8" THEN
        LOCATE 5,40
        PRINT "NAME OF COLD LIQUID ";
        INPUT N2S(8)
    END IF
    locate 5,5 : PRINT "PLATE CHARACTERISTIC";
    locate 6,5
        INPUT "SURFACE AREA PER PLATE,AP (M^2)= " ,AP(1)
    IF AP(1)=0 THEN
        AP(1)=0.05
    END IF
    locate 6,52 : PRINT USING "#.#####"; AP(1);
    locate 7,5 : INPUT "LENGTH OF PLATE,LP (M)= " ,LP(1)
    IF LP(1)=0 THEN
        LP(1)=0.445
    END IF
    locate 7,52 : PRINT USING "#.#####"; LP(1);
    locate 8,5 : INPUT "THICKNESS OF PLATE,XP (M)= " ,XP(1)
    IF XP(1)=0 THEN
        XP(1)=0.0006
    END IF
    locate 8,52 : PRINT USING "#.#####"; XP(1);
    locate 9,5 : INPUT "WIDTH OF PLATE,WP (M)= " ,WP(1)
    IF WP(1)=0 THEN
        WP(1)=0.1125

```




```

END IF
locate 9,52 : PRINT USING "#.#####"; WP(1);
locate 10,5 : INPUT "PLATE GAP, BP (M)= "; BP(1)
IF BP(1)=0 THEN
    BP(1)=0.00313
END IF
locate 10,52 : PRINT USING "#.#####"; BP(1);
A290:
locate 11,5 : INPUT "FOULING FACTOR OF THE HOT STREAM, FH (M^2K/W)= "; WHS
IF LEN(WHS) > 0 THEN
    FH(1) = VAL(WHS)
    GOTO A291
ELSE
    IF AS = "8" THEN
        PRINT CHR$(7)
        locate 24,25 : PRINT "NO HAVE DEFAULT VALUE";
        GOTO A290
    END IF
    IF AS = "1" THEN
        FH(1) = 0.00001*5.6783
    ELSE
        FH(1) = 0.00002*5.6783
    END IF
END IF
A291:
locate 11,52 : PRINT USING "#.#####"; FH(1);
A295:
locate 12,5 : INPUT "FOULING FACTOR OF THE COLD STREAM, FC (M^2K/W)= "; WCS
IF LEN(WCS) > 0 THEN
    FC(1) = VAL(WCS)
    GOTO A300
ELSE
    IF BS = "8" THEN
        PRINT CHR$(7)
        locate 24,25 : PRINT "NO HAVE DEFAULT VALUE";
        GOTO A295
    END IF
    IF BS = "1" THEN
        FC(1) = 0.00001*5.6783
    ELSE
        FC(1) = 0.00002*5.6783
    END IF
END IF
A300:
locate 24,25 : PRINT " ";
locate 12,52 : PRINT USING "#.#####"; FC(1);
A301:
locate 13,5 : INPUT "HOT STREAM FLOW RATE, W (KG/S) "; WH(1)
IF WH(1) <= 0 THEN
    locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T FLOW ZERO !!! ";
    GOTO A301
END IF
locate 24,25 : PRINT " ";
locate 13,51 : PRINT USING "##.###" ; WH(1);
A302:
locate 14,5 : INPUT "COLD STREAM FLOW RATE, W (KG/S) "; WC(1)
IF WC(1) <= 0 THEN
    locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T FLOW ZERO !!! ";
    GOTO A302
END IF
locate 24,25 : PRINT " ";
locate 14,51 : PRINT USING "##.###"; WC(1);
IF CS="C" THEN

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        GOTO A500
    END IF
A303:
    locate 15,5 : INPUT "INLET TEMPERATURE OF THE COLD STREAM (K)= ",TIC(1)
    IF TIC(1) <= 0 THEN
        locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T TEMPERATURE ZERO !!! ";
        GOTO A303
    END IF
    locate 24,25 : PRINT " ";
    locate 15,50 : PRINT USING "###.##";TIC(1);
A304:
    locate 16,5 : INPUT "OUTLET TEMPERATURE OF THE COLD STREAM (K)= ",TOC(1)
    IF TOC(1) <= 0 THEN
        locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T TEMPERATURE ZERO !!! ";
        GOTO A304
    END IF
    locate 24,25 : PRINT " ";
    locate 16,50 : PRINT USING "###.##";TOC(1);
A305:
    locate 17,5 : INPUT "INLET TEMPERATURE OF THE HOT STREAM (K)= ",TIH(1)
    IF TIH(1) <= 0 THEN
        locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T TEMPERATURE ZERO !!! ";
        GOTO A305
    END IF
    locate 24,25 : PRINT " ";
    locate 17,50 : PRINT USING "###.##";TIH(1);
    GOTO A600
A500:
    locate 15,5 : INPUT "INLET TEMPERATURE OF THE HOT STREAM (K)= ",TIH(1)
    IF TIH(1) <= 0 THEN
        locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T TEMPERATURE ZERO !!! ";
        GOTO A500
    END IF
    locate 24,25 : PRINT " ";
    locate 15,50 : PRINT USING "###.##";TIH(1);
A501:
    locate 16,5 : INPUT "OUTLET TEMPERATURE OF THE HOT STREAM (K)= ",TOH(1)
    IF TOH(1) <= 0 THEN
        locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T TEMPERATURE ZERO !!! ";
        GOTO A501
    END IF
    locate 24,25 : PRINT " ";
    locate 16,51 : PRINT USING "###.##";TOH(1);
A502:
    locate 17,5 : INPUT "INLET TEMPERATURE OF THE COLD STREAM (K)= ",TIC(1)
    IF TIC(1) <= 0 THEN
        locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T TEMPERATURE ZERO !!! ";
        GOTO A502
    END IF
    locate 24,25 : PRINT " ";
    locate 17,51 : PRINT USING "###.##";TIC(1);
A600:
    IF AS = "3" THEN
A6500:
    CLS
        locate 2,5 : PRINT"PHYSICAL PROPERTIES OF THE HOT LIQUID";
        locate 4,5 : INPUT "THERMAL CONDUCTIVITY (W/MK) ",KH(1)
        IF KH(1) <= 0 THEN
            locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T INPUT VALUE ZERO !!! ";
            GOTO A6500
        END IF
        locate 24,25 : PRINT " ";
        locate 4,34 : PRINT USING "##.###";KH(1);

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locate 24,25 : PRINT "
A6501:
locate 5,5 : INPUT "VISCOSITY (KG/MS) ",MMH(1)
IF MMH(1) <= 0 THEN
  locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T INPUT VALUE ZERO !!! ";
  GOTO A6501
END IF
locate 5,24 : PRINT USING "##.####";MMH(1);
locate 24,25 : PRINT "
A6502:
locate 6,5 : INPUT "DENSITY (KG/M^3) ",SH(1)
IF SH(1) <= 0 THEN
  locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T INPUT VALUE ZERO !!! ";
  GOTO A6502
END IF
locate 6,23 : PRINT USING "###.#";SH(1);
locate 24,25 : PRINT "
A6503:
locate 7,5 : INPUT "SPECIFIC HEAT (KJ/KGK) ",CPH(1)
IF CPH(1) <= 0 THEN
  locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T INPUT VALUE ZERO !!! ";
  GOTO A6503
END IF
locate 7,29 : PRINT USING "##.####";CPH(1);
locate 24,25 : PRINT "
END IF
IF BS = "8" THEN
A6504:
CLS
locate 9,5 : PRINT " PHYSICAL PROPERTIES OF THE COLD LIQUID";
locate 10,5 : INPUT "THERMAL CONDUCTIVITY (W/MK) ",KC(1)
IF KC(1) <= 0 THEN
  locate 24,31 : PRINT CHR$(7); : PRINT "CAN'T INPUT VALUE ZERO !!! ";
  GOTO A6504
END IF
locate 10,34 : PRINT USING "##.####";KC(1);
locate 24,25 : PRINT "
A6505:
locate 11,5 : INPUT "VISCOSITY (KG/MS) ",MMC(1)
IF MMC(1) <= 0 THEN
  locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T INPUT VALUE ZERO !!! ";
  GOTO A6505
END IF
locate 11,24 : PRINT USING "##.####";MMC(1);
locate 24,25 : PRINT "
A6506:
locate 12,5 : INPUT "DENSITY (KG/M^3) ",SC(1)
IF SC(1) <= 0 THEN
  locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T INPUT VALUE ZERO !!! ";
  GOTO A6506
END IF
locate 12,23 : PRINT USING "###.#";SC(1);
locate 24,25 : PRINT "
A6507:
locate 13,5 : INPUT "SPECIFIC HEAT (KJ/KGK) ",CPC(1)
IF CPC(1) <= 0 THEN
  locate 24,25 : PRINT CHR$(7); : PRINT "CAN'T INPUT VALUE ZERO !!! ";
  GOTO A6507
END IF
locate 13,29 : PRINT USING "##.####";CPC(1);
locate 24,25 : PRINT "
END IF

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IF CS="H" THEN
  TAC(1)=(TIC(1)+TOC(1))/2
ELSE
  TAH(1)=(TIH(1)+TOH(1))/2
END IF
IF CS="C" THEN
  GOSUB A6000
ELSE
  GOSUB A7000
END IF
GOSUB A5500
IF CS="H" THEN
  Q(1)=WC(1)*CPC(1)*(TOC(1)-TIC(1))
ELSE
  Q(1)=WH(1)*CPH(1)*(TIH(1)-TOH(1))
END IF
IF CS="H" THEN
  TOH(1)=TIH(1)-(Q(1)/(WH(1)*CPH(1)))
ELSE
  TOC(1)=TIC(1)+(Q(1)/(WC(1)*CPC(1)))
END IF
TAC(1)=(TIC(1)+TOC(1))/2
TAH(1)=(TIH(1)+TOH(1))/2
IF CS="C" THEN
  GOSUB A7100
ELSE
  GOSUB A6100
END IF
IF WH(1)*CPH(1) > WC(1)*CPC(1) THEN
  GOTO A1000
END IF
CMIN(1)= WH(1)*CPH(1)
CMAX(1)= WC(1)*CPC(1)
E(1)=(CMAX(1)*(TOC(1)-TIC(1)))/(CMIN(1)*(TIH(1)-TOH(1)))
GOTO A2000
A1000:
0   CMIN(1)= WC(1)*CPC(1)
    CMAX(1)= WH(1)*CPH(1)
    E(1)= (CMAX(1)*(TIH(1)-TOH(1)))/(CMIN(1)*(TIH(1)-TIC(1)))
A2000:
R(1)=CMIN(1)/CMAX(1)
REH(1)=(WH(1))/(WP(1)*MMH(1))
REC(1)=(WC(1))/(WP(1)*MMC(1))
W(1) = 0.02*((REH(1))^0.87)
W(2) = ((CPH(1) * MMH(1)) / (KH(1) * 10^(-3))) ^ 0.78
W(3) = KH(1)/(2*BP(1))
HH(1)= W(1) * W(2) * W(3)
W(1) = 0.02*((REC(1))^0.87)
W(2) = ((CPC(1) * MMC(1)) / (KC(1) * 10^(-3))) ^ 0.78
W(3) = KC(1)/(2*BP(1))
HC(1)= W(1) * W(2) * W(3)
W(1) = 1/HH(1)
W(2) = XP(1) / 16.26858
W(3) = 1/HC(1)
UAV(1)=1/( W(1) + W(2)+ W(3) + FH(1)+FC(1))
IF R(1)=0 THEN
  GOSUB A2100
  GOTO A3000
END IF
IF R(1)=0.25 THEN
  GOSUB A2200
  GOTO A3000
END IF

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IF R(1)=0.75 THEN
  GOSUB A2300
  GOTO A3000
END IF
IF R(1)=1 THEN
  GOSUB A2400
  GOTO A3000
END IF
IF R(1)<1 AND R(1)>0.75 THEN
  GOSUB A2500
  GOTO A3000
END IF
IF R(1)<0.75 AND R(1)>0.25 THEN
  GOSUB A2600
  GOTO A3000
END IF
IF R(1)<0.25 AND R(1)>0 THEN
  GOSUB A2700
  GOTO A3000
END IF
A2100:
IF E(1)>0.25 AND E(1)<0.61 THEN
  NTU(1)=2.1064*E(1)-0.2882
  RETURN
END IF
IF E(1)>0.60 AND E(1)<0.956 THEN
  NTU(1)=10^(1.6035*E(1)-0.9766)
  RETURN
END IF
IF E(1)>0.955 AND E(1)<0.986 THEN
  NTU(1)=10^(4.5566*E(1)-3.7555)
  RETURN
ELSE
  NTU(1)=10^(11.0835*E(1)-10.1839)
  RETURN
END IF
A2200:
IF E(1)>0.29 AND E(1)<0.58 THEN
  NTU(1)=2.2697*E(1)-0.3187
  RETURN
END IF
IF E(1)>0.57 AND E(1)<0.91 THEN
  NTU(1)=10^(1.5259*E(1)-0.8746)
  RETURN
END IF
IF E(1)>0.90 AND E(1)<0.97 THEN
  NTU(1)=10^(2.9962*E(1)-2.1885)
  RETURN
ELSE
  NTU(1)=10^(7.3592*E(1)-6.3692)
  RETURN
END IF
A2300:
IF E(1)>0.29 AND E(1)<0.506 THEN
  NTU(1)=2.8462*E(1)-0.4546
  RETURN
END IF
IF E(1)>0.505 AND E(1)<0.851 THEN
  NTU(1)=10^(1.8756*E(1)-0.9536)
  RETURN
END IF
IF E(1)>0.85 AND E(1)<0.921 THEN
  NTU(1)=10^(3.1191*E(1)-1.9883)

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        RETURN
    ELSE
        NTU(1)=10^(4.9732*E(1)-3.6942)
        RETURN
    END IF
    GOTO A3000
A2400:
    IF E(1)>0.29 AND E(1)<0.471 THEN
        NTU(1)=3.085*E(1)-0.4705
        RETURN
    END IF
    IF E(1)>0.47 AND E(1)<0.651 THEN
        NTU(1)=10^(1.9726*E(1)-0.9303)
        RETURN
    END IF
    IF E(1)>0.65 AND E(1)<0.761 THEN
        NTU(1)=10^(2.2386*E(1)-1.1021)
        RETURN
    ELSE
        NTU(1)=10^(3.6276*E(1)-2.1594)
        RETURN
    END IF
A2500:
    GOSUB A2300
    NTU1(1)=NTU(1)
    GOSUB A2400
    NTU2(1)=NTU(1)
    NTU(1)=((1-R(1))/0.25)*(NTU2(1)-NTU1(1))
    NTU(1)=NTU2(1)-NTU(1)
    RETURN
A2600:
    GOSUB A2200
    NTU1(1)=NTU(1)
    GOSUB A2300
    NTU2(1)=NTU(1)
    NTU(1)=((0.75-R(1))/0.5)*(NTU2(1)-NTU1(1))
    NTU(1)=NTU2(1)-NTU(1)
    RETURN
A2700:
    GOSUB A2100
    NTU1(1)=NTU(1)
    GOSUB A2200
    NTU2(1)=NTU(1)
    NTU(1)=((0.25-R(1))/0.25)*(NTU2(1)-NTU1(1))
    NTU(1)=NTU2(1)-NTU(1)
    RETURN
A3000:
    N(1)=(NTU(1)*CMIN(1))/(UAV(1)*AP(1)*10^(-3))
    FC1(1)=1.22/REC(1)^0.252
    FH1(1)=1.22/REH(1)^0.252
    PC(1)=(FC1(1)*LP(1)*WC(1)^2*10^(-3))/(4*SC(1)*BP(1)^3*WP(1)^2)
    PH(1)=(FH1(1)*LP(1)*WH(1)^2*10^(-3))/(4*SH(1)*BP(1)^3*WP(1)^2)
    ***** mark to be pass *****
    GOSUB HOUSE2
A3010:
    LOCATE 22,16
    print "1) NEW CALCULATION      2) PRINT      3) DJS";
    LOCATE 23,25
    PRINT "PLEASE SELECT"
    locate 23,40
    INPUT " ",DS
    IF LEN(DS) = 0 THEN
        locate 24,25

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PRINT CHR$(7);
locate 24,25
PRINT "NOT ENOUGH CHARACTER ";
END IF
IF LEN(DS) > 1 THEN
locate 23,25
PRINT CHR$(7);
locate 24,25
PRINT "PLEASE INPUT IN RANGE ";
GOTO A3010
END IF
IF DS <> "1" AND DS <> "2" AND DS <> "3" THEN
GOTO A3010
END IF
LOCATE 23,41
PRINT DS;
IF DS = "1" THEN
GOTO START
END IF
IF DS = "2" THEN
GOSUB HOUSE3
GOTO A3010
END IF
IF DS = "3" THEN
CLS
END
END IF
A5500:
IF CS="H" THEN
TAK(1)=T1H(1)
GOSUB A6100
ELSE
TAC(1)=T1C(1)
GOSUB A7100
END IF
RETURN
A6000:
IF AS<>"8" THEN
GOTO A6100
END IF
RETURN
A6100:
IF AS="1" THEN
GOSUB A8000
GOTO A6101
END IF
IF AS="2" THEN
GOSUB A9000
GOTO A6101
END IF
IF AS="3" THEN
GOSUB A10000
GOTO A6101
END IF
IF AS="4" THEN
GOSUB A11000
GOTO A6101
END IF
IF AS="5" THEN
GOSUB A12000
GOTO A6101
END IF
IF AS="6" THEN

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        GOSUB A13000
        GOTO A6101
    END IF
    IF AS="7" THEN
        GOSUB A14000
        GOTO A6101
    END IF
A6101:
    RETURN
A7000:
    IF BS<>"8" THEN
        GOTO A7100
    END IF
    RETURN
A7100:
    IF BS="1" THEN
        GOSUB A15000
        GOTO A7101
    END IF
    IF BS="2" THEN
        GOSUB A16000
        GOTO A7101
    END IF
    IF BS="3" THEN
        GOSUB A17000
        GOTO A7101
    END IF
    IF BS="4" THEN
        GOSUB A18000
        GOTO A7101
    END IF
    IF BS="5" THEN
        GOSUB A19000
        GOTO A7101
    END IF
    IF BS="6" THEN
        GOSUB A20000
        GOTO A7101
    END IF
    IF BS="7" THEN
        GOSUB A21000
        GOTO A7101
    END IF
A7101:
    RETURN
A8000:
    IF TAH(1)<277.45 THEN
        KH(1)=((((TAH(1)-273)*0.007)/4.44)+0.317)*1.7307
        GOTO A8100
    END IF
    IF TAH(1)<284 THEN
        KH(1)=((((TAH(1)-277.44)*0.007)/5.56)+0.324)*1.7307
        GOTO A8100
    END IF
    IF TAH(1)<288.57 THEN
        KH(1)=((((TAH(1)-283.99)*0.007)/5.56)+0.331)*1.7307
        GOTO A8100
    END IF
    IF TAH(1)<294.12 THEN
        KH(1)=((((TAH(1)-288.56)*0.007)/5.55)+0.338)*1.7307
        GOTO A8100
    END IF
    IF TAH(1)<299.68 THEN
```



```

      KH(1)=((((TAH(1)-294.11)*0.006)/5.55)+0.345)*1.7307
      GOTO A8100
    END IF
    IF TAH(1)<305.23 THEN
      KH(1)=((((TAH(1)-299.67)*0.006)/5.55)+0.351)*1.7307
      GOTO A8100
    END IF
    IF TAH(1)<310.19 THEN
      KH(1)=((((TAH(1)-305.23)*0.006)/5.556)+0.357)*1.7307
      GOTO A8100
    END IF
    IF TAH(1)<321.9 THEN
      KH(1)=((((TAH(1)-310.19)*0.009)/11.11)+0.363)*1.7307
      GOTO A8100
    END IF
    IF TAH(1)<333.01 THEN
      KH(1)=((((TAH(1)-321.9)*0.007)/11.11)+0.372)*1.7307
      GOTO A8100
    END IF
    IF TAH(1)<344.12 THEN
      KH(1)=((((TAH(1)-333.01)*0.006)/11.11)+0.379)*1.7307
      GOTO A8100
    END IF
    IF TAH(1)<355.23 THEN
      KH(1)=((((TAH(1)-344.12)*0.005)/11.11)+0.385)*1.7307
      GOTO A8100
    END IF
    IF TAH(1)<366.34 THEN
      KH(1)=((((TAH(1)-355.23)*0.003)/11.11)+0.390)*1.7307
      GOTO A8100
    END IF
    IF TAH(1)<377.45 THEN
      KH(1)=((((TAH(1)-366.33)*0.002)/11.11)+0.393)*1.7307
      GOTO A8100
    END IF
    IF TAH(1)<388.57 THEN
      KH(1)=((((TAH(1)-377.44)*0.001)/11.12)+0.395)*1.7307
      GOTO A8100
    END IF
    IF TAH(1)<410.78 THEN
      KH(1)=0.396 * 1.7303
      GOTO A8100
    END IF
    RETURN
A8100:
  W(1) = TAH(1) - 8.435 - 273
  MMH(2)= 2.1482*(W(1) + SQR(8078.4 + W(1)^2)) - 123
  MMH(1)=(1/MMH(2)) * 0.1
  SH(1) = 1000
  CPH(1)= 4.2
  RETURN
A9000:
  GOSUB A8000
  SH(1)=1.128*10^3
  BR(1)=21
  AAS(1)=951.912
  BS(1)=-2.945
  CPH(1)=(1-(0.006*BR(1)))*4.2
  KH(1)=KH(1)*(1-10^(-5)+556*20)
  MMH(1)=10^(AAS(1)/TAH(1)+BS(1))*10^(-3)
  RETURN
A10000:

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SH(1)=1.176*103
BR(1)=30.7
AAS(1)=1075.743
BS(1)=-3.11777
CPH(1)=(1-(0.006*BR(1)))*4.2
KH(1)=KH(1)*(1-10-5)*556*30)
MMH(1)=10^(AAS(1)/TAH(1)+BS(1))*10-3
RETURN
A11000:
GOSUB A8000
SH(1)= 1.236*103
BR(1)= 40.9
AAS(1)= 1204.186
BS(1)= -3.30012
CPH(1)=(1-(0.006*BR(1)))*4.2
KH(1)=(KH(1)*(1-10-5)*556*40))
MMH(1)=10^(AAS(1)/TAH(1)+BS(1))*10-3
RETURN
A12000:
KH(1)=0.4482604
SH(1)=1.160*103
AAS(1)=1146.385
BS(1)=-3.27634
MMH(1)=10^(AAS(1)/TAH(1)+BS(1))*10-3
MO(1)=(100*(40*SH(1))/92.09)/(((40*SH(1))/92.09)+(60*103/18)))
CPH(1)=(-0.00369*MO(1)+0.902119)*4.2
RETURN
A13000:
KH(1)=0.414511048
SH(1)=1.180*103
AAS(1)=1336.369
BS(1)=-3.71784
MMH(1)=10^(AAS(1)/TAH(1)+BS(1))*10-3
MO(1)=(100*(50*SH(1))/92.09)/(((50*SH(1))/92.09)+(50*103/18)))
CPH(1)=(-0.00369*MO(1)+0.902119)*4.2
RETURN
A14000:
KH(1)=0.3807617
SH(1)=1.211*103
AAS(1)=1375.676
BS(1)=-3.61328
MMH(1)=10^(AAS(1)/TAH(1)+BS(1))*10-3
MO(1)=(100*(60*SH(1))/92.09)/(((60*SH(1))/92.09)+(40*103/18)))
CPH(1)=(-0.00369*MO(1)+0.902119)*4.2
RETURN
A15000:
IF TAC(1)<277.45 THEN
  KC(1)=(((TAC(1)-273)*0.007)/4.44)+0.317)*1.7307
  GOTO A15100
END IF
IF TAC(1)<284 THEN
  KC(1)=(((TAC(1)-277.44)*0.007)/5.56)+0.324)*1.7307
  GOTO A15100
END IF
IF TAC(1)<288.57 THEN
  KC(1)=(((TAC(1)-283.99)*0.007)/5.56)+0.331)*1.7307
  GOTO A15100
END IF
IF TAC(1)<294.12 THEN
  KC(1)=(((TAC(1)-288.56)*0.007)/5.55)+0.338)*1.7307
  GOTO A15100
END IF
IF TAC(1)<299.68 THEN

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```

      KC(1)=((((TAC(1)-294.11)*0.006)/5.56)+0.345)*1.7307
      GOTO A15100
    END IF
    IF TAC(1)<305.23 THEN
      KC(1)=((((TAC(1)-299.67)*0.006)/5.55)-0.351)*1.7307
      GOTO A15100
    END IF
    IF TAC(1)<310.19 THEN
      KC(1)=((((TAC(1)-305.23)*0.006)/5.556)+0.357)*1.7307
      GOTO A15100
    END IF
    IF TAC(1)<321.9 THEN
      KC(1)=((((TAC(1)-310.19)*0.009)/11.11)+0.363)*1.7307
      GOTO A15100
    END IF
    IF TAC(1)<333.01 THEN
      KC(1)=((((TAC(1)-321.9)*0.007)/11.11)+0.372)*1.7307
      GOTO A15100
    END IF
    IF TAC(1)<344.12 THEN
      KC(1)=((((TAC(1)-333.01)+0.006)/11.11)-0.379)*1.7307
      GOTO A15100
    END IF
    IF TAC(1)<355.23 THEN
      KC(1)=((((TAC(1)-344.12)*0.005)/11.11)-0.385)*1.7307
      GOTO A15100
    END IF
    IF TAC(1)<366.34 THEN
      KC(1)=((((TAC(1)-355.23)*0.003)/11.11)+0.390)*1.7307
      GOTO A15100
    END IF
    IF TAC(1)<377.45 THEN
      KC(1)=((((TAC(1)-366.33)*0.002)/11.11)+0.393)*1.7307
      GOTO A15100
    END IF
    IF TAC(1)<388.57 THEN
      KC(1)=((((TAC(1)-377.44)*0.001)/11.12)+0.395)*1.7307
      GOTO A15100
    END IF
    IF TAC(1)<410.78 THEN
      KC(1)=0.396 * 1.7303
      GOTO A15100
    END IF
    RETURN
A15100:
    MMC(2)= TAC(1)-8.435 - 273
    MMC(2)= 2.1482*(MMC(2) + SQR(8078.4 - MMC(2)^2)) - 120
    MMC(1)=(1/MMC(2))*0.1
    SC(1) = 1000
    CPC(1)= 4.2
    RETURN
A16000:
    GOSUB A15000
    SC(1)=1.128*10^3
    BR(1)=2!
    AAS(1)=951.912
    BS(1)=-2.945
    CPC(1)=(1-(0.006*BR(1)))*4.2
    KC(1)=KC(1)*(1-10^(-5)*556*20)
    MMC(1)=10^(AAS(1)/TAC(1)+BS(1))*10^(-3)
    RETURN
A17000:
    GOSUB A15000

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SC(1)=1.176*10^3
BR(1)=30.7
AAS(1)=1075.743
BS(1)=-3.11777
CPC(1)=(1-(0.006*BR(1)))*4.2
KC(1)=KC(1)+(1-10^(-5))*556*30)
MMC(1)=10^(((AAS(1)/TAC(1))+BS(1))*10^-3)
RETURN
A18000:
GOSUB A15000
SC(1)=1.236*10^3
BR(1)= 40.9
AAS(1)=1204.186
BS(1)=-3.30012
CPC(1)=(1-(0.006*BR(1)))*4.2
KC(1)=KC(1)*(1-10^(-5))*556*40)
MMC(1)=10^(AAS(1)/TAC(1)+BS(1))*10^(-3)
RETURN
A19000:
KC(1)=0.4482604
SC(1)=1.160*10^3
AAS(1)=1146.385
BS(1)=-3.27634
MMC(1)=10^(AAS(1)/TAC(1)+BS(1))*10^(-3)
MO(1)=(100*(40+SC(1))/92.09)/(((40+SC(1))/92.09)+(60*10^3/18)))
CPC(1)=(-0.00369*MO(1)+0.902119)*4.2
RETURN
A20000:
KC(1)=0.414511048
SC(1)=1.180*10^3
AAS(1)=1336.369
BS(1)=-3.71784
MMC(1)=10^(AAS(1)/TAC(1)+BS(1))*10^(-3)
MO(1)=(100*(50+SC(1))/92.09)/(((50+SC(1))/92.09)+(50*10^3/18)))
CPC(1)=(-0.00369*MO(1)+0.902119)*4.2
RETURN
A21000:
KC(1)=0.3807617
SC(1)=1.211*10^3
AAS(1)=1375.676
BS(1)=-3.61328
MMC(1)=10^(AAS(1)/TAC(1)+BS(1))*10^(-3)
MO(1)=(100*(60+SC(1))/92.09)/(((60+SC(1))/92.09)+(40*10^3/18)))
CPC(1)=(-0.00369*MO(1)+0.902119)*4.2
RETURN
PRINTOUT:
      PREPARE FOR PRINTOUT
RETURN
HOUSE2:
CLS
PRINT TAB(16);"INPUT DATA"
PRINT TAB(44);"HOT LIQUID      COLD LIQUID"
PRINT TAB(5);"Type";
PRINT TAB(42);N1S(VAL(AS));TAB(60);N2S(VAL(BS))
PRINT TAB(5);"Mass Flow Rate      , KG/S";TAB(45);:PRINT USING "#,###.###" :;WH(1);
PRINT " ";;:PRINT USING "#,###.###";WC(1)
PRINT TAB(5);"Inlet Temperature      , K ";TAB(45);:PRINT USING "#,###.##" :;TIR(1);
PRINT " ";;:PRINT USING "#,###.##";TIC(1)
PRINT TAB(5);"Outlet Temperature      , K ";TAB(45);:PRINT USING "#,###.##" :;TOR(1);
PRINT " ";;:PRINT USING "#,###.##";TOC(1)
PRINT TAB(5);"Fouling Factor      , M^2K/W";TAB(49);:PRINT USING "#.#####" :;FH(1);
PRINT " ";;:PRINT USING "#.#####";FC(1)

```

```

PRINT TAB(16);"PLATE CHARACTERISTICS"
PRINT TAB(5);"Surface Area per Plate"      ,M^2      "":PRINT USING "###.#####";AP(1)
PRINT TAB(5);"Thickness"                  ,M        "":PRINT USING "###.#####";XP(1)
PRINT TAB(5);"LENGTH"                     ,M        "":PRINT USING "###.#####";LP(1)
PRINT TAB(5);"Width"                      ,M        "":PRINT USING "###.#####";WP(1)
PRINT TAB(5);"Plate Gap"                  ,M        "":PRINT USING "###.#####";BP(1)
PRINT TAB(16);"OUTPUT RESULTS"
PRINT TAB(5);"Reynolds Number"             ;TAB(45);:PRINT USING "###.##" ;:REH(1);
PRINT " " ;:PRINT USING "###.##";REC(1)
PRINT TAB(5);"Pressure Drop"              ,KN/M^2";TAB(45);:PRINT USING "###.##" ;:PH(1);
PRINT " " ;:PRINT USING "###.##";PC(1)
PRINT TAB(5);"Heat Transfer Rate"         ,KW       "":PRINT USING "###.##";Q(1)
PRINT TAB(5);"Overall Heat Transfer Coefficient,W/M^2K" ;:PRINT USING "###.##";UAV(1)
PRINT TAB(5);"Total Surface Area Required",M^2      "":PRINT USING "###.##";AP(1)*N(1)
PRINT TAB(5);"Number of Thermal Plates"   "":PRINT USING "###.##";N(1)
RETURN
HOUSE3:
CLS
LPRINT TAB(16);"INPUT DATA"
LPRINT TAB(44);"HOT LIQUID      COLD LIQUID"
LPRINT TAB(5);"Type":
LPRINT TAB(42);N1S(VAL(A5));TAB(60);N2S(VAL(B5))
LPRINT TAB(5);"Mass Flow Rate"            ,KG/S";tab(45);:LPRINT USING "###.####" ;:WH(1);
LPRINT " " ;:LPRINT USING "###.####";WC(1)
LPRINT TAB(5);"Inlet Temperature"        ,K ;:tab(45);:LPRINT USING "###.##" ;:TIH(1);
LPRINT " " ;:LPRINT USING "###.##";TIC(1)
LPRINT TAB(5);"Outlet Temperature"       ,K ;:tab(45);:LPRINT USING "###.##" ;:TOH(1);
LPRINT " " ;:LPRINT USING "###.##";TOC(1)
LPRINT TAB(5);"Fouling Factor"           ,M^2K/W";tab(49);:LPRINT USING "###.####" ;:FH(1);
LPRINT " " ;:LPRINT USING "###.####";FC(1)
LPRINT TAB(16);"PLATE CHARACTERISTICS"
LPRINT TAB(5);"Surface Area per Plate"    ,M^2      "":LPRINT USING "###.#####";AP(1)
LPRINT TAB(5);"Thickness"                ,M        "":LPRINT USING "###.#####";XP(1)
LPRINT TAB(5);"Width"                    ,M        "":LPRINT USING "###.#####";WP(1)
LPRINT TAB(5);"LENGTH"                   ,M        "":LPRINT USING "###.#####";LP(1)
LPRINT TAB(5);"Plate Gap"                ,M        "":LPRINT USING "###.#####";BP(1)
LPRINT
LPRINT TAB(16);"OUTPUT RESULTS"
LPRINT TAB(5);"Reynolds Number"           ;TAB(45);:LPRINT USING "###.##" ;:REH(1);
LPRINT " " ;:LPRINT USING "###.##";REC(1)
LPRINT TAB(5);"Pressure Drop"            ,KN/M^2";TAB(45);:LPRINT USING "###.##" ;:PH(1);
LPRINT " " ;:LPRINT USING "###.##";PC(1)
LPRINT TAB(5);"Heat Transfer Rate"       ,KW       "":LPRINT USING "###.##";Q(1)
LPRINT TAB(5);"Overall Heat Transfer Coefficient,W/M^2K" ;:LPRINT USING "###.##";UAV(1)
LPRINT TAB(5);"Total Surface Area Required",M^2      "":LPRINT USING "###.##";AP(1)*N(1)
LPRINT TAB(5);"Number of Thermal Plates" "":LPRINT USING "###.##";N(1)
RETURN

```



APPENDIX B

Physical properties of liquids

B.1 Water

B.1.1 Viscosity

The viscosity relationship for water as a function of temperature is as follow [25]:

$$\frac{1}{\mu} = (2.1482 * [(t-8.435) + \sqrt{8078.4 + (t-8.435)^2}] - 120)$$

where μ = viscosity ,poise
 t = temperature ,°C

B.1.2 Thermal Conductivity

Values of the thermal conductivity and Prandtl number of water as a function of temperature are presented in the table below [6]:

Temperature (°C)	Thermal Conductivity (W/m.K)	Prandtl number (dimensionless)
21.11	0.597	6.83
26.67	0.607	5.92
32.22	0.618	5.18
37.78	0.628	4.57
48.89	0.644	3.65
50.00	0.656	3.01
71.11	0.666	2.52
82.22	0.675	2.16
93.33	0.680	1.89

B.1.3 Specific heat

The specific heat of water is essentially constant [25]:

$$C_P = 4.1868 \text{ kJ/kg.K}$$

B.1.4 Density

The density of water is essentially assumed constant throughout this study.

$$\rho = 1,000 \text{ kg/m}^3$$

B.2 Syrup solution (Sucrose Solution)

B.2.1 Viscosity

The viscosity of sucrose solution depends on the percentage of sucrose by weight, and on the temperature. In the present study sucrose solutions of 20, 30 and 40 percent by weight were used. The viscosity data taken from Perry's Chemical Engineer's Handbook (1963) are presented in Table B-1. The equation used to estimate the viscosity of liquid as a function of temperature is as follows:

$$\log \mu = (A/T) + B \quad (B-1)$$

where μ = viscosity, cp
 T = absolute temperature, K

The constant A and B are the slope and intercept of the plot $\log \mu$ vs. $(1/T)$, respectively. The temperature-viscosity relations for 20 and 40 percent by weight sucrose solutions are shown in Fig. B-1 based on the data from Table B-1. The relation for 30 percent by weight sucrose solution correlation is presented in Fig. B-2 based on our own experimental data shown in Table B-2.

Table B-1 Viscosity of Sucrose Solutions

1/T ($\times 10^{-3}$) (K^{-1})	Percentage sucrose by weight			
	20	40	$\log \mu_{20}$	$\log \mu_{40}$
3.663	3.818	14.820	0.582	1.171
3.597	3.166	11.600	0.501	1.064
3.533	2.662	9.830	0.425	0.993
3.472	2.275	7.496	0.357	0.875
3.412	1.967	6.223	0.294	0.794
3.355	1.710	5.206	0.233	0.717
3.300	1.510	4.398	0.179	0.643
3.246	1.336	3.776	0.126	0.577
3.194	1.197	3.261	0.078	0.513
3.144	1.074	2.858	0.031	0.456
3.095	0.974	2.506	- 0.011	0.399
3.048	0.887	2.227	- 0.052	0.348
3.003	0.811	1.989	- 0.091	0.299
2.958	0.745	1.785	- 0.128	0.252
2.915	0.588	1.614	- 0.162	0.208
2.873	0.637	1.467	- 0.196	0.166
2.832	0.592	1.339	- 0.228	0.127
2.793	0.552	1.226	- 0.258	0.088
2.754	-	1.127	-	0.052
2.717	-	1.041	-	0.017

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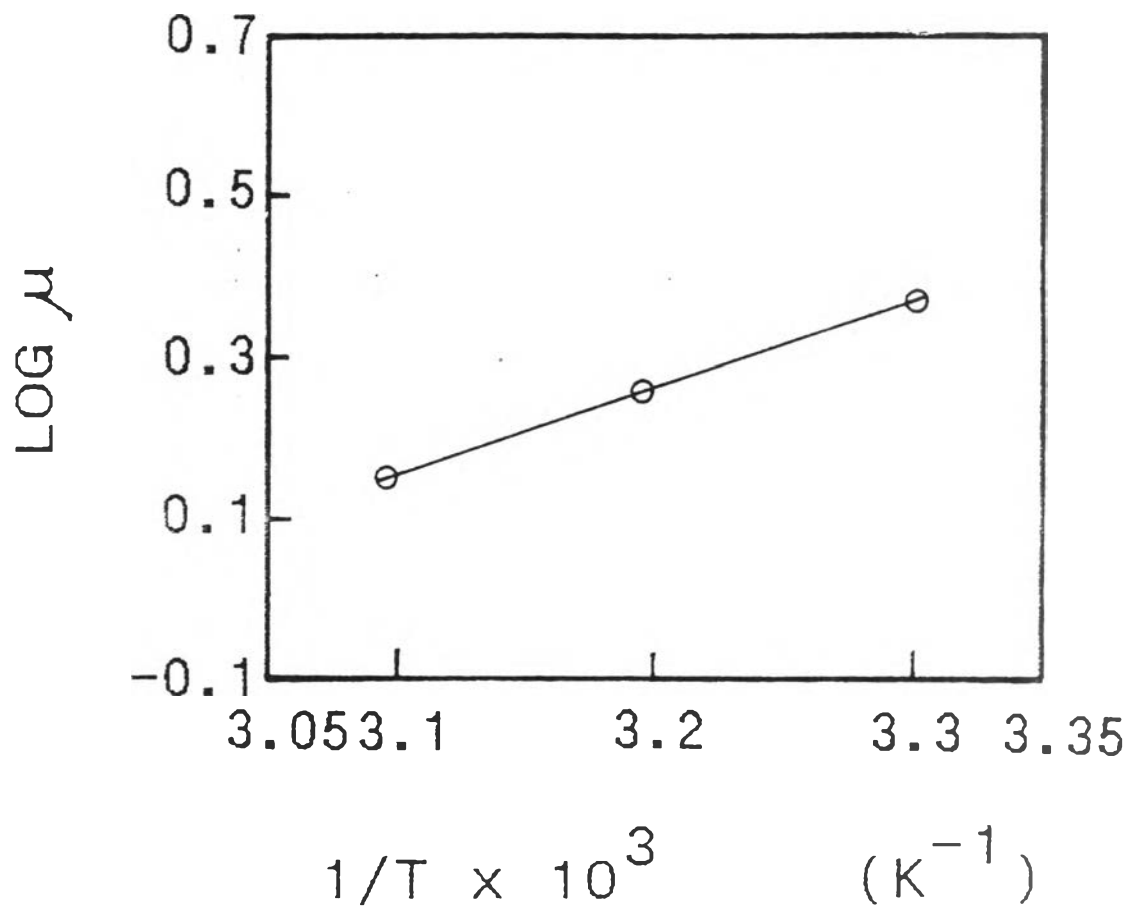


Figure B-2 Temperature-viscosity relation for 30 wt% sucrose solution
(Based on measured data).

Table 3-2 Experimental measurement of viscosity of 30% by weight sugar solution.

$1/T$ $(\times 10^{-3})$ (K^{-1})	μ (cp)	$\log \mu_{30}$
3.300	2.354	0.372
3.194	1.823	0.261
3.095	1.419	0.152

The slope and intercept of the temperature-viscosity relation for each sucrose solution used in this study are given in the following table:

Percent sucrose by weight	slope A	intercept B
20	951.912	- 2.994
30	1075.743	- 3.118
40	1204.186	- 3.300

B.2.2 Thermal Conductivity

The thermal conductivity of the sucrose solution can be calculated using the following equation [26]:

$$K = K_w (1 - 10^{-5} \alpha p)$$

where K_w = conductivity of water at the same temperature applied, 10^{-5} watt/cm. $^{\circ}$ C
 p = grams of solute sucrose per 100 g of solution
 α = constant = 556 for sucrose solution, $^{\circ}$ C
 K = thermal conductivity of sucrose solution, 10^{-5} watt/cm. $^{\circ}$ C

B.2.3 Specific heat

The specific heat of the sucrose solution may be approximated using the following equation [27,28]:

$$C_p = 1 - 0.006*B$$

where B = percent brix of the solution, brix
 C_p = heat capacity, g/cal- $^{\circ}$ C

A refractometer is used to measure the percent brix of the solution, which is presented in the following table:

Percent sucrose by weight	Percent Brix
20	21.0
30	30.7
40	40.9

B.2.4 Density

The density of the sucrose solution is assumed to be independent of temperature. The density of the sucrose solution, which is measured with a piconometer at room temperature (31°C), is listed in the table below:

Percent sucrose by weight	$\rho \times 10^3$ (kg/m ³)
20	1.1280
30	1.1757
40	1.2364

B.3 Glycerine

B.3.1 Viscosity

In the present study glycerine solutions of 40, 50 and 60 percent by volume of glycerine are used. The measured value of the viscosity as a function of temperature is presented in Table B-3. The temperature-viscosity plot for the glycerine solution based on equation B-1 is presented in Fig. B-3.

Table B-3 Viscosity measurement of glycerine solution as a function of concentration in volume % and temperature.

$1/T$ ($\times 10^{-3}$) (K^{-1})	glycerine % by volume	μ (cp)	$\rho \times 10^3$ (kg/m^3)	$\log \mu$
3.300	40	3.197	1.1603	0.505
	50	4.915	1.1804	0.692
	60	8.372	1.2114	0.923
3.194	40	2.461	1.1603	0.391
	50	3.581	1.1804	0.554
	60	6.170	1.2114	0.790
3.095	40	1.863	1.1603	0.270
	50	2.620	1.1804	0.418
	60	4.380	1.2114	0.641

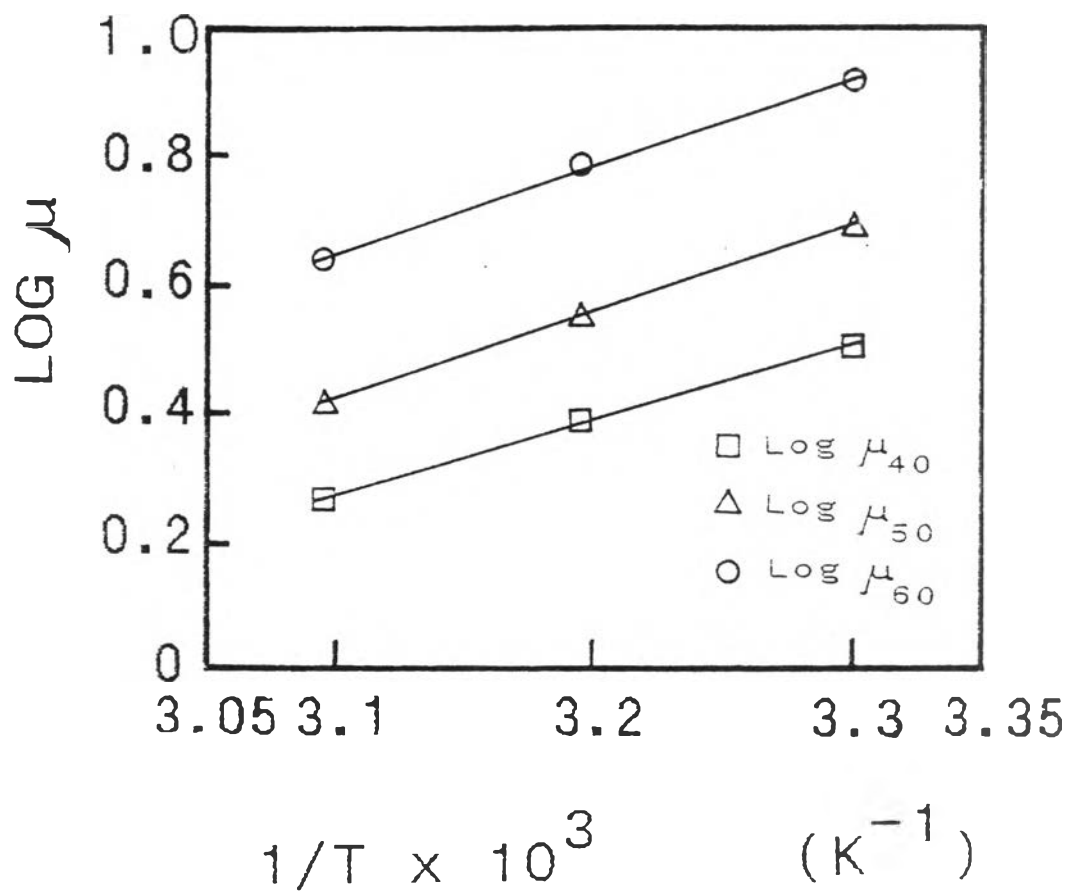


Figure B-3 Temperature-viscosity relations for glycerine solution
(Based on measured data).

The slope and intercept of temperature-viscosity plot for glycerine are listed in the following table:

Percent glycerine by volume	slope A	intercept B
40	1146.385	- 3.276
50	1336.369	- 3.718
60	1375.676	- 3.613

B.3.2 Thermal Conductivity

The thermal conductivity of glycerine is assumed to be independent of temperature within the range of 20 to 100 °C. Presented below is Perry's Chemical Engineers' Handbook's data for the thermal conductivity of glycerine.

Temperature (°C)	Percent volume of glycerine	Thermal Conductivity (W/m.K)
20	100	0.2838
20	80	0.3271
20	60	0.3808
20	40	0.4483
20	20	0.4811
100	100	0.2838

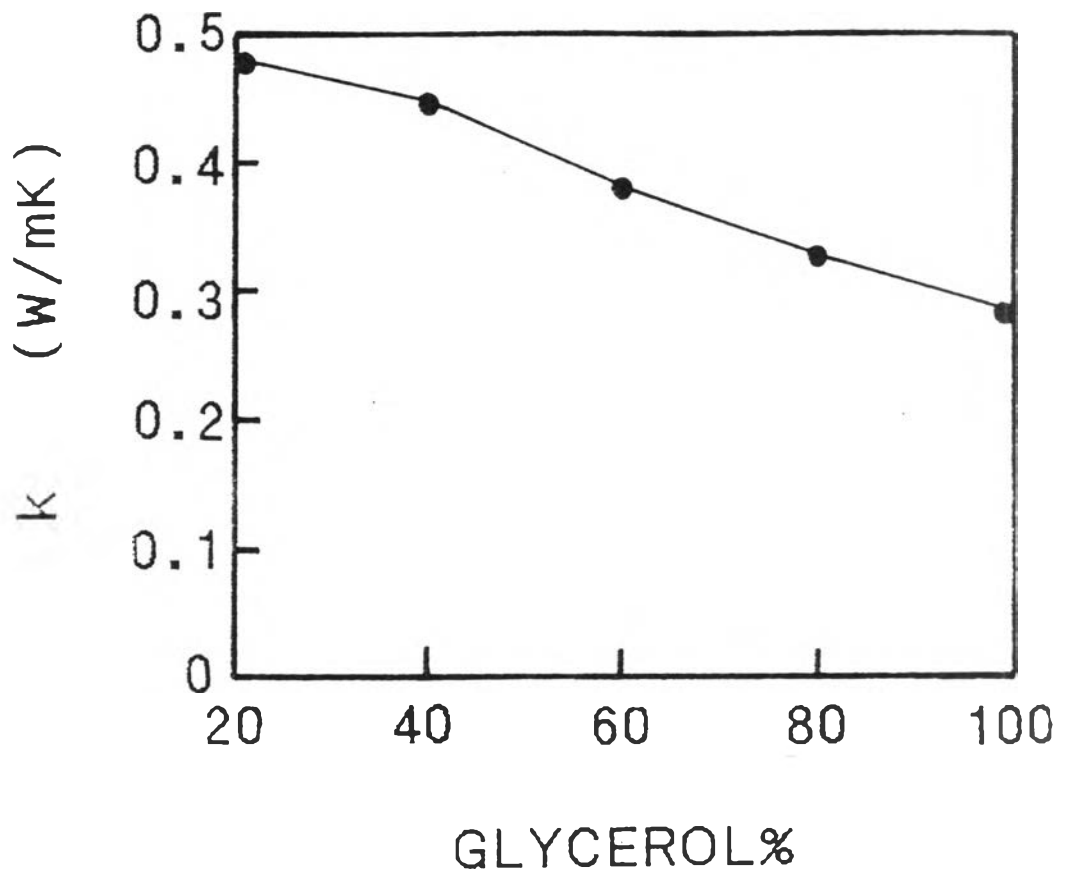


Figure B-4 Thermal conductivity versus Glycerine concentration (vol%)
(Based on Perry's Chemical Engineer's Handbook
Fourth Edition, 1963).

Fig. B-4 shows the plot of thermal conductivity of glycerine versus glycerine concentration as obtained from Perry's Chemical Engineers' Handbook.

B.3.3 Specific heat

The specific heat of aqueous solutions of glycerol, which is obtained from Perry's Chemical Engineers' Handbook is listed below:

Percent mole of glycerine	Specific heat (cal./g-°C)
2.12	0.960
4.56	0.924
11.50	0.841
22.70	0.758
43.90	0.672
100.00	0.576

Fig. B-5 shows the plot of specific heat of glycerine versus mole % of glycerine, as obtained from Perry's Chemical Engineers' Handbook.

B.3.4 Density

The density of glycerine is assumed independent of

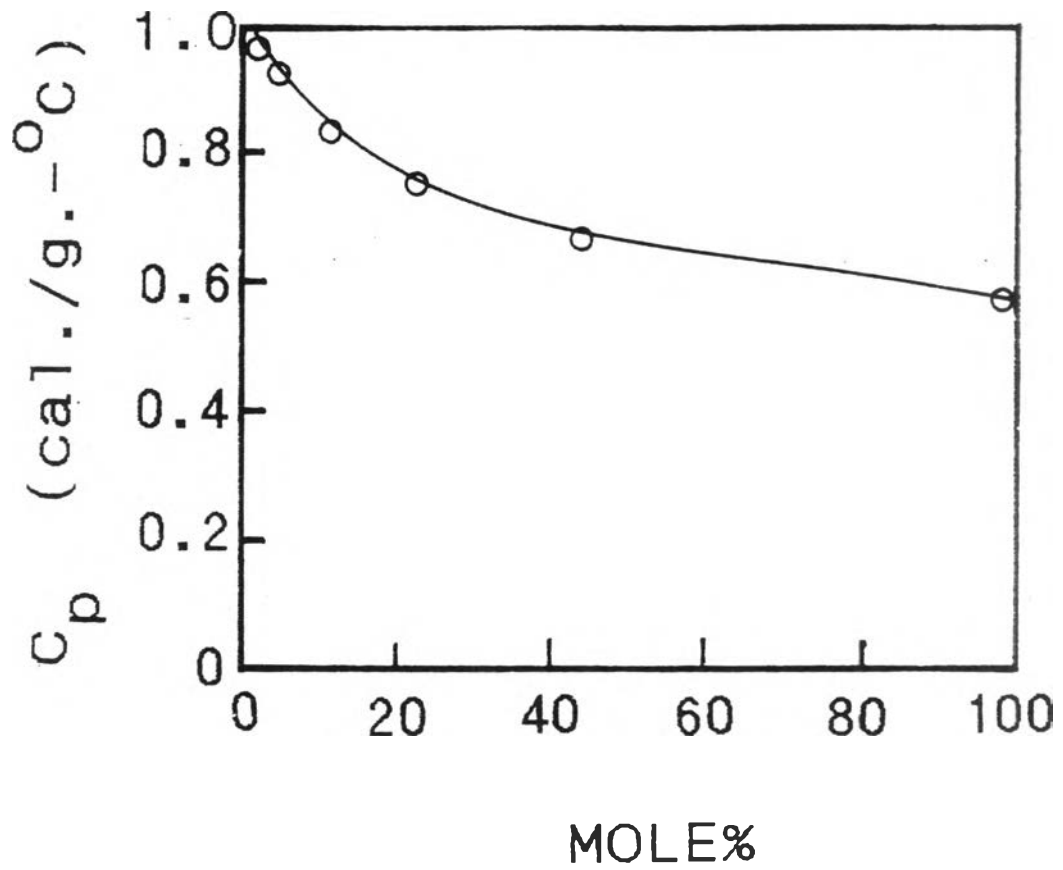


Figure B-5 Specific heat versus Glycerine concentration (mole %)
(Based on Perry's Chemical Engineer's Handbook Fourth
Edition, 1963).

temperature. The density of glycerine, which is measured using a picnometer at room temperature (31°C), is presented in the table below:

Percent glycerine by volume	$\rho \times 10^3$ (kg/m^3)
40	1.1603
50	1.1804
60	1.2114



AUTOBIOGRAPHY

Miss Dhanyarat Kritsernvong was born on August 3, 1963. She received her Bachelor of Science in Chemistry from Faculty of Science, Kasetsart University in 1986. She continued her Master's study at Chulalongkorn University in 1986.