INTRODUCTION

On-line Measurement of Yarn Faults during Spinning

Application of computer, microprocessors and on-line measurement and monitoring of different parameters in the preparatory and spinning process have become the common feature of modern spinning machines. Autolevelling at carding and draw frame, automatic material correction can be introduced that will ensure an improvement both in productivity and quality for all subsequent processes with continuous on-line data collection in different type of spinning systems. The introduction of these systems, will however, result in a reduction in the number of 'off-line' quality control processes, results in improving productivity and quality control in yarn production.

Due to more and more emphasis on diversification and manufacturing of yarns for export, the question of improving upon the existing method of measurement of evenness is loosing importance and on-line measurement of evenness and yarn faults are now essential but the process could not be adopted due to very high cost of the instrument and software. In this project, an attempt has been made to develop the instrument and software at negligible cost, so that the same can be used by most of the spinning mill.

The nature of irregularity observed in a yarn has two distinct features:

- A general and gradual variation of the diameter or mass of yarn throughout its length; and
- A localized conglomeration of fibres producing thick and thin places and neps at certain intervals along the length of the yarn.

In the previous paper, the measurement of mass variation has been discussed. In this research work, measurement of yarn faults with and software-controlled digital data processing technique having a distinct advantage of yielding more accurate results and higher reliability.

Faults—Classification and Measurement

Yarn faults may be defined as yarn irregularities that can lead to difficulties in subsequent production stages, or to defects in fabric. Faults can be broadly classified into two categories as in Figure 1. The seldom-occurring faults have a cross-section of +100% and more and their frequency is very small compared to that of frequently occurring faults.

Frequently Occurring Faults

These faults can be divided into three main classes. They are:

1. Thick places
2. Thin places
3. Neps

![Figure 1 Yarn faults classification](image-url)
These faults, generally referred to as imperfections, can be further subdivided into four levels depending upon the size of fault with reference to mean yarn cross-section.

<table>
<thead>
<tr>
<th>Level</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin</td>
<td>–30 –40 –50 –60</td>
</tr>
<tr>
<td>Thick</td>
<td>+100 +70 +50 +35</td>
</tr>
<tr>
<td>Neps</td>
<td>+400 +280 +200 +140</td>
</tr>
</tbody>
</table>

Nep is a thick place having length shorter than 4 mm with a reference length of 1 mm. Thick places are longer than 4 mm and shorter than 8 cm and thin places are shorter than 8 cm. Generally for comparing the results, thin places (–50%), thick places (+50%) and neps (+200%) are chosen.

**Seldom Occurring Faults**

The faults which occur less frequently like slubs, fly, piecing etc are referred to as seldom occurring faults. These faults are generally measured on either uester classimat system or classi-fault system.

**Classimat System UCM II**

The classimat UCM II system provides a detailed break up of yarn faults based on the length and dimension of the faults. The different classes of faults are shown in Figure 2.

There are totally 23 types of faults: each fault is identified by an alphabet; the alphabet represents the length range of the fault. ‘A’ faults have a length range of 0.1 cm-1 cm, ‘B’ faults 1 cm-2 cm, ‘C’ faults 2 cm-4 cm and so on. The alphabets A to G indicate the thick yarn faults while the letters represent the thin faults.

<table>
<thead>
<tr>
<th>Level</th>
<th>Percentage</th>
</tr>
</thead>
</table>
| Numerical values indicate the percentage increase in cross-sectional size. The number 1 represents the fault of size +100% up to +150% over the nominal cross-section in case of thick places and –30% up to –45% in case of thin places. The number 2 means +150% up to +250% for thick places and –45% up to –65% for thin places and so on.

**Specification of the Major Components used for Development of Amplifier Unit**

1. Operational amplifier: CA 3140 having input impedance 1.5 × 106.
2. Operational amplifier: LF 356 having input impedance 1 × 106.
4. Power supply (0-12 V dc, 500 amp) : LM 7812 +ve voltage regulator.

**Precaution taken in the Measuring System**

1. Proper ear thing.
2. Proper shielding to avoid stray noises.
3. Selection of good quality components required for the development of the amplifier and dc power supply unit.
4. Input voltage in the computer should never increase more than 10 V.

**Software Development**

1. Mass variation in the yarn is measured by capacitive type measuring head/sensor/probe.
2. The variation in mass in + and – range is observed on the galvanometer.
3. Output voltage from the capacitor varies according to the mass variation measured by the sensor.
4. Output voltage from the capacitor (600 mv dc-1600 mv dc) is fed to the instrumentation amplifier in dc mode for amplifying the dc voltage in the desired range of the AD card (0 V-10 V).
5. The output voltage for maximum and minimum mass variation is measured by means of multimeter.
6. The voltage variation is fed analogically to the analogue to digital card.
7. The maximum and minimum voltage is for maximum and minimum diameter variation can be represented by the software programming and the yarn faults can be measured by the software programming by using suitable formula.

**Figure 2** Block schematic diagram of the measurement process
Those digital data are displayed on the monitor graphically in on-line manner by means of software programming.

Those on-line graphical data are stored in a memory by means of software programming.

**Software Programming**

The entire logic of data capturing and subsequent on-line data display using menu driven interactive format has been implemented using the Q-BASIC\(^1\) programming language. The flowchart of programming control flow has been shown in Figure 3.

**EXPERIMENTAL RESULTS AND DISCUSSION**

Parallel type capacitors actually sense the mass by means of capacity variation of the system. But in this project work, the mass variation has been converted to diameter variation by developing software and instrument. The output signal corresponding to different count gives a polynomial equation, which is given in the programming part. Two different such equations have been obtained one for cotton and another for polyester. The signal from the parallel type capacitor has been fed to the computer through the AD card. Due to the variation of yarn diameter, the output signal also varies. The yarn diameter and its variation have been calculated from the polynomial equation and thus, the imperfections can also be calculated. Though today’s UT-3 machines are available from which U%, thick place, thin place and neps can be calculated but the UT-3 is very costly and it is not possible to achieve by all the means. The software, which has been developed in Q-Basic, by interfacing with computer, the m/c with capacitor (parallel plate type) becomes fully automatic and economic. Now, it is very easier to measure the diameter, its variation, CV%, mass variation and PMD.

**CONCLUSION**

1. It is a real time information measurement and if there is any defect it can be rectified immediately.
2. The process is cost effective, informative and time saving.
3. The diameter of the yarn, which is near about original diameter, can be calculated.
4. The CV and diameter can be measured.

### Table 1 Observed yarn faults (per km of yarn) on the computer screen

<table>
<thead>
<tr>
<th>Yarn Type</th>
<th>Count</th>
<th>Number of thick places</th>
<th>Number of thin places</th>
<th>Number of neps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>30</td>
<td>884</td>
<td>156</td>
<td>35</td>
</tr>
<tr>
<td>Polyester</td>
<td>40</td>
<td>13</td>
<td>765</td>
<td>2</td>
</tr>
</tbody>
</table>

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Vol 84, February 2004
5. By the application of this software in Q-Basic and interfacing with computer the conventional user can be modified and it is comparable to present generation UT-3 and it is economically too cheaper.

**AS ON COMPUTER SCREEN AFTER RUNNING THE PROGRAMME**

**Step-1**

- Press SPACE BAR TO GO TO NEXT MENU....
- Press ENTER TO GO TO NEXT SUB MENU....
- Press ESC TO CLEAR THE OPEN MENU BAR....

**Step-2 (for Yarn Faults)**

Enter the machine speed (meter per minute)

? Enter the yarn count (10 to 60)

? Enter the thick percentage (general val 50%)

? Enter the thin percentage (general val 50%)

? Enter the neps percentage (general val 200%)

? Enter the type of yarn 1-Cotton, 2-Polyester

Enter 1 to see the original dia/time
Enter 2 to see the dia variation with respect to time

**Step-3**

- DIAMETER VARIATION =
- DIAMETER VARIATION =
- DIAMETER VARIATION =
- DIAMETER VARIATION =
- DIAMETER VARIATION =

**Step-4**

- Press Pg Up to go to previous page

**REFERENCES**

3. Dr S M Chatterjee and Dr S Bhattacharyya, *et al.* 'Measurement of Mass Variation of Yarn through Interfacing with Computer-Project.'
4. P Balasubramanian. 'Faults in Synthetic and Blended Yarns.' *Indo Rama Synthetics (I) Ltd*.
5. J E Booth. 'Principles of Textile Testing.'
6. Hearle, Grosberg, Baker. 'Structural Mechanics of Fibres.' 'Yarns and
Fabrics’.
7. Helfrick, Cooper. ‘Modern Electronics Instrumentation and Measurement Techniques.’
8. Electronic Instrumentation, Kalsi.

APPENDIX
Pr.Bas
CLS
10 SCREEN 12
V$ = INKEY$
PAINT (100, 100), 0, 15
LINE (50, 10) – (637, 470), 15, B
LINE (110, 50) – (515, 130), 15, B
FOR K = 516 TO 520 STEP 1
LINE (K, 55) – (K, 135), 8
NEXT K
FOR P = 115 TO 520 STEP 1
LINE (P, 131) – (P, 135) 8
NEXT P
COLOR 2
LOCATE 5, 23
PRINT “ON-LINE MEASUREMENT OF YARN FAULTS”
COLOR 2
LOCATE 6, 27
‘PRINT “AND ITS ON-LINE CONTROL”
COLOR 2
LOCATE 6, 33
PRINT “THROUGH”
COLOR 2
LOCATE 7, 25
PRINT “INERFACING WITH COMPUTER”
LINE (175, 200) – (435, 305), 15, B
LINE (185, 205) – (425, 255), 15, B
COLOR 2
LOCATE 14, 35
PRINT “UNDER”
COLOR 11
LOCATE 15, 26
PRINT “DR SATYAKI BHATTACHARYYA”
COLOR 2
LOCATE 18, 25
PRINT “COLLEGE OF TEXTILE TECHNOLOGY”
COLOR 2
LOCATE 19, 35
PRINT “SERAMPORE”
IF V$ = CHR$(27) THEN SYSTEM
LOCATE 28, 30
COLOR 10
PRINT “PRESS C TO CONTINUE”
IF V$ = CHR$(67) OR V$ = CHR$(99) THEN GO TO 30
GO TO 10
‘**************************************************************************
30 CHAIN “C:\QBASIC\MAIN1.BAS”
MAIN1.BAS
CLS
10 SCREEN 12
PAINT (100, 100), 8
LINE (55, 50) – (255, 200), 7, BF
LOCATE 5, 14
COLOR 14
PRINT CHR$ (17); “MAIN MENU”; CHR$ (16)
COLOR 10
LOCATE 7, 8
PRINT “THICK, THIN, NEPS ”; CHR$ (16)
COLOR 10
LOCATE 9,8
PRINT “    MASS     ”; CHR$ (16)
COLOR 10
PRINT “PRESS SPACEBAR TO GO NEXT MENU....”
LOCATE 20, 8
PRINT “PRESS ENTER TO GO NEXT SUB MENU....”
LOCATE 23, 8
PRINT “PRESS ESC TO CLEAR THE OPEN MENU BAR....”
X = 7: Y = 8
DO
V$ = INKEY$
IF V$ = CHR$(32) THEN GOSUB 100
IF X = 7 AND Y = 8 THEN
LOCATE X, Y

Vol 84, February 2004
PRINT "THICK, THIN, NEPS"; CHR$(16)
GOSUB 150
GOSUB 150
END IF
IF X = 7 AND Y = 8 AND V$ = CHR$(13) THEN
  LOCATE 7, 8
  LOCATE X, Y
  PRINT "THICK, THIN, NEPS"; CHR$(16)
  CHAIN "C:\Q-BASIC\FF.BAS"
END IF
IF X = 9 AND Y = 8 AND V$ = CHR$(13) THEN
  LOCATE 9, 8
  LOCATE X, Y
  PRINT "THICK, THIN, NEPS"; CHR$(16)
END IF
**************************************************************************
100
X = X + 2: Y = 8
IF X > 9 AND Y = 8 THEN
  X = 7: Y = 8
END IF
RETURN
**************************************************************************
150
FOR P = 0 TO 4000: NEXT P
RETURN
**************************************************************************
LOCATE X, Y
PRINT "ON-LINE AVERAGE YARN MASS ";
GOSUB 150
LOCATE X, Y
PRINT "ON-LINE AVERAGE YARN MASS ";
GOSUB 150
END IF
IF X = 7 AND Y = 37 AND V$ = CHR$ (13) THEN
CHAIN "C:\QBASIC\MASSVAR.BAS"
END IF
IF X = 9 AND Y = 37 AND V$ = CHR$ (13) THEN
CHAIN "C:\QBASIC\DATAMASS.BAS"
END IF
LOOP

CLS
SCREEN 12
COLOR 10
LOCATE 4, 10
PRINT "ENTER THE MACHINE SPEED (METER PER MINUTE)"
LOCATE 5, 10
INPUT MCSPEED
LOCATE 6, 10
PRINT "ENTER THE YARN COUNT (10 TO 60)"
LOCATE 7, 10
INPUT C
LOCATE 8, 10
PRINT "ENTER THE THICK PERCENTAGE (GENERAL VAL 50%)"
LOCATE 9, 10
INPUT THICKPER
LOCATE 10, 10
PRINT "ENTER THE THIN PERCENTAGE (GENERAL VAL 50 %)"
LOCATE 11, 10
INPUT THINPER
LOCATE 12, 10
PRINT "ENTER THE NEPS PERCENTAGE (GENERAL VAL 200 %)"
LOCATE 13, 10
INPUT NEPSPER
LOCATE 14, 10
PRINT "ENTER THE TYPE OF YARN 1-COTTON, 2-POLYESTER"
LOCATE 15, 10
INPUT CHOICE
IF CHOICE <> 1 AND CHOICE <> 2 THEN
LOCATE 18, 10
PRINT "TYPE CORRECT CHOICE"
LOCATE 22, 10
INPUT CHOICE
SPE = 1.4
IF (CHOICE = 1) THEN
SPE = 1.8
END IF
IF (CHOICE = 2) THEN
SPE = 1.05
END IF
RDIA = 0.86729 * SQR (SPE)/(SQR (C))
CLOSE #1
CLOSE #2
CLOSE #3
BA = 768
OUT (BA + 20), 192
OUT (BA + 20), 64
OUT (BA + 20), 192
X = INP (BA + 16)
Y = INP (BA + 18)
W = 256 * Y + X
V = W/65536
V1 = 10 * V * 3
LOCATE 24, 10
PRINT "ENTER 1 TO SEE THE ORIGINAL DIA/TIME"
LOCATE 25, 10
PRINT "ENTER 2 TO SEE THE DIA VARIATION WITH RESPECT TO TIME"
LOCATE 28, 10
INPUT Z
XX = 0
YY = 0
NEPS = 0
G = 0
G4 = 0
N = 0
S = 0
TIMER ON
STARTTIME = TIMER
IF (Z = 1) THEN
OPEN "O", #1 "C:\Q-BASIC\DATA.REC"
OPEN "O", #3, "C:\Q-BASIC\CV.REC"
10 CLS
SCREEN 12
COLOR 10
DRAW "BM10, 10 CL R600 D450 1600 U450"
PAINT (100, 100), 8
LOCATE 3, 14
PRINT "ON-LINE GRAPHICAL REPRESENTATION OF DIAMETER"
LOCATE 7, 6
PRINT "0.30 MM"
LOCATE 10, 6
PRINT "0.25 MM"
LOCATE 13, 6
PRINT "0.20 MM"
LOCATE 16, 6
PRINT "0.15 MM"
LOCATE 19, 6
PRINT "0.10 MM"
LOCATE 22, 6
PRINT "0.05 MM"
LOCATE 25, 6
PRINT "0.00 MM"
LINE (100, 400) – (600, 401), 0, BF
LINE (100, 60) – (101, 400), 0, BF
A = 100 : B = 230
J = 100
DO
BA = 768
N = N + 1
OUT (BA + 20), 192
OUT (BA + 20), 64
OUT (BA + 20), 192
X = INP (BA + 16)
Y = INP (BA + 18)
W = 256 * Y + X
V = W/65536
V1 = 10 * V * 2.5
IF CHOICE = 2 THEN
V1 = 30 * V
END IF
IF CHOICE = 2 THEN
DIA = (-0.3707) * V1 * V1 – 15.768 + 4.8805 * V1
ELSEIF CHOICE = 1 THEN
DIA = 0.4126 * V1 – 0.0193 * V1 * V1 – 1.6278
END IF
LOCATE 22, 50
PRINT "DIA ="
LOCATE 22, 55
PRINT USING; ";#.###"; DIA
IF (DIA < (1 – (THINPER/100)) * RDIA) THEN
XX = XX + 1
END IF
IF (DIA > (1 + (THICKPER/100)) * RDIA AND DIA < (1 + (NEPSPER/100)) * RDIA) THEN
YY = YY + 1
END IF
IF (DIA > (1 + (NEPSPER/100)) * RDIA) THEN
NEPS = NEPS + 1
END IF
S = S + DIA
AVG = S/N
IF V1 > 15 THEN
V1 = 15
END IF
IF V1 < 3 THEN
V1 = 3
END IF
LOCATE 28, 50
TIMEPAST = TIMER – STARTTIME
RUNLENGTH = TIMEPAST * (MCSPEED/60)
LOCATE 28, 8
PRINT "TIME PAST= "; TIMEPAST
LOCATE 28, 25
PRINT "SECONDS"
LOCATE 24, 50

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PRINT "V1 =";
PRINT USING; "##.###"; V1;
WRITE #1, DIA
IF (C > 5 AND C < 15) THEN
VR = 745
ELSEIF C > 15 AND C < 20 THEN
VR = 805
ELSEIF C > 20 AND C < 25 THEN
VR = 815
ELSEIF C > 25 AND C < 35 THEN
VR = 825
ELSEIF C > 35 AND C < 45 THEN
VR = 850
ELSEIF C > 45 AND C < 55 THEN
VR = 865
ELSE
VR = 880
END IF
LINE (A, B) – (J, VR – (V1 * 95)), 3
A = J
B = (VR – (V1 * 95))
J = J + 2
IF J = 600 THEN
J = 100
GOTO 10
END IF
DELAY1 = 7000
DO
DELAY1 = DELAY1 – 1
LOOP UNTIL DELAY1 = 0
LOOP UNTIL INKEY$ = CHR$ (27)
END IF
'GRAPH OF DIA VARIATION
IF (Z = 2) THEN
OPEN "O", #1, "C:\Q-BASIC\DATA.REC"
OPEN "O", #2, "C:\Q-BASIC\DIAVAR.REC"
OPEN "O", #3, "C:\Q-BASIC\CV.REC"
IF CHOICE = 2 THEN
DIA = (- 0.3707) * V1 * V1 – 1.6278
END IF
DIAVAR = RDIA – DIA
15 CLS
SCREEN 12
COLOR 10
LOCATE 28, 10
PRINT "PLEASE PRESS L TO SEE DATA"
DRAW “BM10, 10 CL R600 D450 1600 U450”
PAINT (100, 100), 8
LOCATE 3, 14
PRINT "MEASUREMENT OF IMPERFECTIONS IN A YARN"
LOCATE 5, 6
PRINT “+100%”
LOCATE 25, 6
PRINT “-100%”
LOCATE 15, 6
PRINT “0%”
LINE (80, 230) – (600, 230, 5), 0, BF
LINE (100, 60) – (101, 400), 0, BF
SD = 0
C = 0
C12 = 0
A = 100: B = 230
J = 100
DO
BA = 768
N = N + 1
OUT (BA + 20), 192
OUT (BA + 20), 64
OUT (BA + 20), 192
X = INP (BA + 16)
Y = INP (BA + 18)
W = 256 * Y + X
V = W/65536
V1 = 10 * V * 2.5
IF CHOICE = 2 THEN
V1 = V * 30
END IF
IF CHOICE = 2 THEN
DIA = (- 0.3707) * V1 * V1 – 15.768 + 4.8805 * V1
ELSEIF CHOICE = 1 THEN
DIA = (0.4126 * V1) – (0.0193 * V1 * V1) – 1.6278
END IF
LOCATE 25, 50
PRINT “DIA=”
LOCATE 25, 56
PRINT USING; “0.###”; DIA
IF (DIA < (1 – (THINPER/100)) * RDIA) THEN
XX = XX + 1
END IF
IF (DIA > (1 + (THICKPER/100)) * RDIA AND DIA < (1 + NEPSPER/100)) * RDIA) THEN
YY = YY + 1
END IF
IF (DIA > (1 + (NEPSPER/100)) * RDIA) THEN
NEPS = NEPS + 1
END IF
WRITE #1, DIA
LET D = (DIA – RDIA) * (DIA – RDIA)
C = C + D
D12 = (DIA – RDIA)
IF D12 < 0 THEN
D12 = – D12
END IF
C12 = (C12 + D12)
IF C12 < 0 THEN
C12 = – C12
END IF
SD = SQR (C/N)
CV = SD * 100/RDIA
PMD = CV/1.25
IF V1 > 15 THEN
V1 = 5
END IF
IF V1 < 3 THEN
V1 = 1
END IF
LET DIAVAR (PERCENT) = (DIA – RDIA) * 100/RDIA
LET D = (DIA – RDIA) * (DIA – RDIA)
C = C + D
SD = SQR (C/N)
CV = SD * 100/RDIA
WRITE #2, DIAVAR (PERCENT)
LOCATE 28, 50
TIMEPAST = TIMER – STARTTIME
RUNLENGTH = TIMEPAST * (MCSPEED/60)
LOCATE 28, 10
PRINT “TIMEPAST =”; TIMEPAST
LOCATE 28, 25
PRINT “SECONDS”
LINE (A, B) – (J, (780 – V1 * 90)), 3
A = J
B = 780 – V1 * 90
J = J + 2
IF J = 600 THEN
J = 100
GOTO 15
END IF
DELAY1 = 6000
DO
DELAY1 = DELAY1 – 1
LOOP UNTIL DELAY1 = 0
LOOP UNTIL INKEY$ = CHR$ (27)
END IF
SCREEN 8
COLOR 10, 8
TKIND = 0
TNIND = 0
NIND = – 1
THICKTEST = YY * 1000/RUNLENGTH
THINTEST = XX * 1000/RUNLENGTH
NEPSTEST = NEPS * 1000/RUNLENGTH
DO
TKIND = TKIND + 1
LOOP UNTIL (THICKTEST < TKIND)
DO
TNIND = TNIND + 1
LOOP UNTIL (THINTEST < TNIND)
DO
NIND = NIND + 1
LOOP UNTIL (NEPTEST < NIND)
NIND = NIND – 1
IF (NIND < 0) THEN
    NIND = 0
END IF
LOCATE 5, 20
PRINT "PER KILOMETER OF YARN"
LOCATE 8, 20
PRINT "NO OF THICK PLACES= "; TKIND
LOCATE 10, 20
PRINT "NO OF THIN PLACES= "; TNIND
LOCATE 12, 20
PRINT "NO OF NEPS= "; NIND
A$ = INPUT$ (1)
CLOSE #1
CLOSE #2
CLOSE #3
CHAIN "C:\Q-BASIC\MAIN1.BAS"
302 END
DATAMASS.BAS
CLS
KEY OFF
SCREEN 12
CLOSE
OPEN "I", #1, "C:\Q-BASIC\DAT1.REC"
X = 2: Y = 5
CTR = 0
C = 0
V2 = 0
S = 0
A = 0
B = 0
DO
    INPUT #1, MASS
    CTR = CTR + 1
    C = C + 1
    S = S + MASS
    LOCATE X, Y
    COLOR 12
    PRINT "MASS VARIATION = "; USING "##########.##";
    MASS
    X = X + 1
    V2 = V1 + V2
    AVGMASSVARIATION (PERCENTAGE) = S/C
    A = MASS * MASS + A
    IF X > 27 THEN
        X = 2: Y = Y + 35
    END IF
    IF CTR > 50 THEN
        CTR = 0
        COLOR 14
        LOCATE 29, 50
        PRINT "PRESS ANY KEY TO CONTINUE..."
        ANS$ = INPUT$ (1)
        CLS
        X = 2: Y = 5
        LOCATE X, Y
    END IF
LOOP UNTIL (EOF(1))
V2 = V2/C
B = A/(C – 1)
CV = SQR (B)
LOCATE 29, 15
COLOR 9
PRINT "AVERAGE MASS VARIATION (PERCENTAGE) = "; USING "##########.##";
AVGMASSVARIATION (PERCENTAGE)
PRINT " CO-EFFICIENT OF VARIATION = "; USING "####.####";
CV
ANS$ = INPUT$ (1)
ANS$ = INPUT$ (1)
CHAIN "C:\Q-BASIC\MAIN1.BAS"