COMPUTERIZATION OF DEFORMATION STUDIES OF PHYSICAL STRUCTURES

BY

AYOOLA, JOHN OLUSEYI

PGD/MCS/98/99/868

A PROJECT SUBMITTED TO THE DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF POST – GRADUATE DIPLOMA (PGD) IN COMPUTER SCIENCE

SEPTEMBER, 2000

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SEPTEMBER, 2000

DECLARATION

I hereby certify that this project was written by me in partial fulfilment for the award of Post – Graduate Diploma (PGD) in Computer Science.

J. Ayoola

....

Ayoola, John Oluseyi

23-10-2000

....

Date

CERTIFICATION

This project entitled "Computerization of Deformation Studies of Physical Structures" by Ayoola, John Oluseyi of the Department of Maths/Computer Science, Reg. No PGD/MCS/98/99/868 meet the regulations governing the award of Post-Graduate Diploma in Computer Science of the Federal University Technology, Minna.

.... Date..........................

Prof. K.R. Adeboye

(Supervisor)

.... Date..........................

Dr. S.A. Reju

(Head of Department)

.... Date..........................

(External Examiner)

DEDICATION

This project is dedicated to the Almighty God and all accident victims.

ACKNOWLEDGEMENT

I express my profound gratitude to the Almighty God who made it possible for me to complete this course and project successfully.

My special thanks go to my project supervisor Prof. K.R. Adeboye. Who at the same time the Dean of School of Science and Science Education, for his unreserved efforts to see to the successful completion of this project.

Also my appreciation go to the H.O.D Maths/Computer Department and all the Department's Lecturers who has contributed in one way or the other to ensure the smooth running of this project and the program in general.

My utmost appreciation goes to my parent Mr. & Mrs J.O Ayoola my uncle Chief Makanjuola Ayoola and my brothers, Ayodele, Olusegun, Olushola and Oladotun for their support morally and financially, throughout the program until the date.

I can not but remember Rev. J.A Funmilayo and family uncle Biyi Babatunde, the Olabodes, Ahmed Adebola, Muyiwa Ayansola and Yusuf Suleman who contributed in no small way towards the completion of the course.

My special gratitude goes to Mr. Kayode Folayan, Lawrence, Nike, Kemi and all my course mates for their corporation and understanding throughout the course.

I can not but thank Miss Elizabeth Samuel and Miss Kemi Usman who helped in typing this project.

May God show you all the right way in all your future endeavours through Christ Jesus. (Amen)

TABLE OF CONTENTS

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE

ABSTRACT

This project is on computerization of Deformation Studies of Physical Structures. The report consist of five chapters all which gives information about the relevant aspects of computerizing Deformation Studies ranging from feasibility study, system analysis and design and the programming aspect depicting the data processing procedures to obtain collated data which is in turn used for the analysis of deformable structure.

CHAPTER ONE

1.1 INTRODUCTION

Surveying is defined as the act of making measurement of relative positions of natural and man– made features on the earth surface and the plotting of this measurement to some suitable scale to form a map or plan.

Surveying is divided into different branches. Some of which are discussed below.

Geodetic surveying as the name implies, is the field observation made for the purpose of Geodesy, which is the science of determining the size and shape of the earth and its gravity field. These are surveys generally carried out on natural basis, which provides survey stations. These stations are used as control points to position both Topographical and cadastral surveys when necessary.

Surveying are surveys undertaken to define and record the boundaries of properties, legislature areas and even countries. The plans produced from the survey form the basis of system of statutory registration of ownership and other right over land.

Hydrographical surveying is that branch of surveying which deals with bodies of water. It embraces all surveys made of the determination of water areas volume and levels, rate of flow and characteristics of under water surface.

Topographical surveying have for their object the preparation of maps as complete in details as the scale will allow. They are distinct from cadastral surveys, the primary objective of which is the location and representation of boundaries and the measurement of areas of land which fulfil various purposes, civil and military for which reference to general map is required.

Engineering surveying are surveys undertaken to provide special information for construction projects. They are essentially large scale topographical surveys, supplying details for a particular engineering scheme and could include the setting out of works on the ground. There are normal plane surveys, but on large project such as motor ways, monitoring and deformation studies of structures and pipelines some geodetic controls may be necessary.

Large structures like buildings, dams, bridges etc built with their foundation resting on the ground of different Geological formation: pillars of bridges under pressure of heavy traffic changes in temperature, earthquake etc may show little or no movement but with time it may lead to the collapse or deformation of these structures.

There are many causes of gradual settling of building on clay soil due to long term consolidation and short term movement due to the compaction of granular soil.

It may however, be necessary to determine the extent and direction of such movement in order to obtain an insight into their character as a safety measure. In the case of structures the second reason is the collation of data for future design. The best arrangement to this end is to carry out periodical measurement and compare the results.

It is however, pertinent to note that the periodical measurement process is the deformation study of structures requiring great care in handling the data, be it the previously collected of the new ones. This data are processed to obtain the desired information needed to be collated. And the findings in the collated data will assist in decision making.

Furthermore, there has to be provision made for data that are yet to be collected because the study is a continuous process. It is worth mentioning that with time, the volume of the processed data will be too much to be handled manually when it comes to the stage of comparison of newly processed data and the previous ones.

Thus, the need to introduce a more sophisticated data processing method arises.

Bearing in mind some of the benefit of computer i.e. speed, reliability, efficiency and storage capability. It is necessary to computerize the deformation studies of physical structures.

1.2 OBJECTIVES OF THE STUDY

Before any system is designed, its objectives must be
clearly defined. These objectives will reflect the goals established by the management for the entire organization.

The objectives of this study are:

(i) To reduce cost of management and maximize output: the cost of carrying out the periodic measurement has to be reduced to the barest minimum and the output be maximized. This can only be done with the introduction.

(ii) To save time: Since the time lag in processing data is very long, a new system has to be introduce to speed up the data processing time.

(iii) To eliminate record duplication and conflicting data: any time a new observation is taken, the previous record has to be transferred to a new sheet in order to update the data for collation and if care is not taken, there may be conflicting data. Hence a new system that can handle this process efficiently has to be introduced.

(iv) To define the orderly method of handling data: The procedural method of data processing for deformation studies requires a great care in handling data and if care is not taken, during computation, data can be muddled up. So the orderly method of handling data will be defined.

(v) To ease data retrieval and analysis: When retrieving data, files are too many to go through and copy out not to even talk of the time it will take one to analyze the result of the collation. The introduction of a new system that will ease data retrieval analysis should be desirable.

1.3 THE SCOPE OF THE STUDY

It is always the aim of the researcher to have a study scope that will cover all the areas of its study. That is, cover the deformation study of all physical structures that can be monitored such as bridges, buildings, dam sites, pipelines etc, but due to time constraint and the cost of undertaking the research, the scope of the study only covers that of building and the library complex of the Federal School of Surveying, Oyo is used.

Observation has been made for three consecutive years and the computational processes as well as the collation done manually.

1.4 PROBLEM DEFINITION

Before solving any problem, there must be a clear definition of such problem. The following question may help in defining the problem:

- What is the problem?
- What are the details of the problem?
- Are the output information from the present system reliable enough for decision making purpose?
- Does the present data processing operation over use the time and energy of the data processing staff?
- Is the current volume of data large enough to justify the introduction a more sophisticated data processing method?
- Is the current system rigid or flexible?
- Will the current system be able to handle large future volume of data?
- How can be present system be improved?
- What are the current system's cost?

Summarily, the problem is with the working process of the current system and the following were the findings:

(i) The reliability of the output information can only be tested by the number of times the computational process is repeated and checked.

(ii) The time and energy used in carrying out the process as well as the cost of running it could be enormous.

(iii) Though the volume of current data is not large enough for the introduction of a sophisticated data processing method, but it is obvious that if the reliability of processed data is measured by the number of times it is repeatedly carried out, checked and counter checked then, an increase in the current volume of data will make the working process more cumbersome to handle.

CHAPTER TWO

2.0 LITERATURE REVIEW AND FEASIBILITY STUDY

2.1 LITERATURE REVIEW

It is well known that certain types of terrain moves slowly and consequently, the relative location of point which are situated in such areas changes also. A few causes of such movements are: volcanic activities causing instability; a soft layer of soil tending to move downward on a slopping rock formation ultimately cause landslide; change of ground water level etc

Large structure may show small displacement in absolute and relative sense due to great variety of causes example of this are: structure built with their foundation resting on ground of different geological formation; pillar of bridges under pressure of heavy traffic; earthquakes etc.

It may be necessary to determine the extent and direction of such movement in order to have an insight into their character as a safety measure and future design.

In order to obtain an insight into the movement of large structures, a simplified explanation will be sufficient. Generally, movement with respect to structure may be classified into three types:

(1) Relative or differential movement within structures causing permanent and elastic deformation: The pattern of these movements depends entirely on the type of structure and the outside factors that cause them. It is therefore not possible to make any specification without additional data.

(2) Absolute movement of structures as a whole, considered as a rigid body. They commence as soon as the foundations are laid, the weight steadily increasing until the construction is finished.

(3) As a consequence of the absolute movements, movement in the adjacent to the structure may occur. These may be sub-divided into permanent and elastic ones and may either be in lateral or vertical directions. The movements are usually relatively rigid at first and slow down as the construction proceeds.

Deformation studies, as a operation, is the science of detecting the gradual movements, alteration or changes in the original shape and size of a particular structure due to strength or material used for construction, nature of the land on which the structure is erected, excess weight of structure, poor construction expertise of the builder, faulty structural calculation, structures not erected to design standard etc.

Deformation deals with the determination of the geometrical status of a deformable body and the changes in its shape and dimensions.

Stability on the other hand deals with the real position of such a body or structure with respect to its surroundings.

The most important reason for deformation and stability monitoring is the safety of lives and properties including those being monitored. Several examples exist in literature to draw attention to the importance of deformation monitoring e.g. The Wellington oil field in Los – Angeles country, California had experienced over 9 metres of subsidence. Mexico also experienced up to 9 metres of subsidence (AJIBADE NIS – AGM 1997)

Over the years there have been an information concerning the monitoring of the National Theatre Igarmu, Lagos State that this large structure is sinking. Through the re-survey of the structure, the percentage of the sinking can be known when results obtained from consecutive studies are compared and analyzed (UDABOR 1998).

Sometimes ago there was also another information about the bridge at Jebba town, that fly over river Niger, that due to hold – up at the bridge end, there was a sinking on the bridge. Due to all this information our large structures needs to be monitored as a result of the resultant physical changes. Examples of such structures are dam sites like Kainji dam, Jebba, Shiroro dam etc; building like the male hostels, the senate building, the library complex and the lecture theatre all of the University should be monitored.

2.2 METHODOLOGY OF STUDY

This is concerned with the collection of information about the existing manual system, the identification of problems and difficulties of the existing system.

The work is carried out using the following steps:

(i) Examining the current system

(ii) Determining what is wrong with this system and comparing alternative methods of achieving the same result at a faster and convenient rate.

(iii) Researching into design alternatives.

(iv) Employing programming methods found in Qbasic textbooks and

(v) Consulting other books and programs written to solve similar problem.

2.3 FEASIBILITY STUDY

This is done in order to determine whether a solution to the problem is feasible. This prevents the wasting of time and money of the project is too, too uncontrollable, or simple impossible to carry out.

The main concept of feasibility studies carried out on the existing system and a thorough assessment of all possible alternative solution were done.

(i) Operational Feasibility:- This is concerned with the workability of the proposed information system when developed and installed. It was however found that if new system is designed in accordance to the working principles of the studies it will work efficiently when installed.

(ii) Technical feasibility: - This is concerned with analysis of the efficiency of the new system with the current equipment, existing software and available personnel.

(iii) Economical feasibility: - This has to do with the financial feasibility. This is undertaken to access in relation with the long term expected gains. The expected benefits outweighs the estimated cost, thus, the proposed system is worth pursuing.

CHAPTER THREE

3.0 SYSTEM ANALYSIS AND DESIGN

3.1 SYSTEM ANALYSIS

This analysis is defined as the method of determining how best to use the computer with other resources to perform tasks which meets the information needs of users.

Before any case for change in the system of operation arises for consideration, the idea for changes must first be identified and fully examined critically to justify the need for change.

This part of the project concentrates on an in-depth study of the existing system of operation in order to isolate its problem and seek possible solution to them in the design of a new system.

The major data processing technique in the current system cannot handle a large volume of data since it is manually done. That is, the traverse, leveling and intersection computation for the perimeter, environmental (lawn) and the structural pillars are done manually in a repeated form. The collation of the computed data which is the major part in the deformation studies as presently carried out, can also not meet the needs as far as speed and time rate is concerned.

3.2 SYSTEM DESIGN

System design involves the design of new forms for recording data input and output, new data processing method and ways of conveying data from its source to the data processing department.

The purpose of the design phase is to transform the conceptual design of the new or proposed system. There is the need for proper understanding of the overall and precise objective of the system. Its objective is to develop a well-organised database system for handling data in order to facilitate the operation and the decision making for the studies.

The design phase takes care of the following activities involved in the design of the new system.

3.2.1 OVERALL DESIGN

The system is designed to be highly interactive easy – to – use and menu driven. Menu by its meaning, is a list of options available from which a choice could be made. In this wise, at each level of the system a list of option is made available from which the operation to be performed could be selected.

3.2.2 OUTPUT DESIGN

This is another stage of the system design that readily comes to mind the moment a system is conceived and proposed to be designed. This could be described in plain term as the layout of the output or report to be generated.

This can naturally, be subjected to the simple fact that is the targeted output that determines the input method of processing that ensures output.

In case where results are required to be generated with regards to the system being considered, users are prompted to determine the destination of the result which may either be on the screen or printed out as hard copy (on the printer).

However, the output of the process is in three forms.

(i) Perimeter pillars output: This covers the results of the collation of the geometrical values of each pillars, so also is similar output expected for

(ii) Environmental pillar and

(iii) Structural pillar outputs

3.2.3 INPUT DESIGN

This simply allows the system to determine the data type to input bearing in mind the format of the output specification of the system. The system will now consider the following data type for processing in order to achieve the design output.

(i) Data for environmental pillar: This includes data for traverse computation (Distances and angles measured) and for leveling computation.

(ii) Data for perimeter pillar: This is of the same data requirement with the environmental pillar.

(iii) Data for structural pillars: This includes data for intersection computation as well as that of the heighting computation.

3.3 COST AND BENEFITS ANALYSIS

When system analysis and design is completed and the analysis is convinced that the new data processing system is worth embarking upon, a cost benefits analysis is necessary in order to find out whether it is economically worth while to invest on the project.

3.3.1 COST ANALYSIS

The cost analysis of the proposed system is as analyzed below:

[A] OPERATING COST

Consumables (Diskettes, Ink stationaries etc)	= N60,000.00
Equipment maintenance	= N120,000.00
Program maintenance	= N75,000.00
Labour cost (3 operators)	= N54,000.00
Utilities	= N30,000.00
Miscellaneous expenses	= N60,000.00
2 A/C (2HP)	= N160,000.00
TOTAL	= N559,000.00

[B] DEVELOPMENT COST

System Analysis and Design for 4 weeks	=	N100,000.00
Software Development	=	N60,000.00
4 personal computer	=	N440,000.00
1 printer	=	N75,000.00
Installation cost	=	N60,000.00
TOTAL	=	N735,000.00

GRAND TOTAL OF 1 AND 2 = N1, 294,000.00

3.3.2 BENEFITS OF THE PROPOSED SYSTEM

The benefits includes:

(i) Timely production of information when required

(ii) Reduction in the use of paper work

(iii) Automatic updating of records and maintenance

(iv) Elimination of many repetition works during computation.

(v) Faster data processing technique.

CHAPTER FOUR

4.0 SOFTWARE DEVELOPMENT AND IMPLEMENTATION

4.1 FLOW CHARTS AND PROGRAMS

Flow charts, which are referred to as a logical diagrammatic representation of how a system operates, is composed of symbols representing specific activities and their direction of flow is generally from top to the bottom of a page.

When the flow chart is logically correct, the conversion of the design into any programming language will not be a problem.

However, this section of the chapter contains the flow chart of the working procedure of the new system alongside with its program as the process is being carried out in stages.

4.2 PROGRAM IMPLEMENTATION

This is the process of coding, testing and documenting the programs in the system. This process takes as much as 60 to 70 percent of the overall system development effort. It involves the development of quality assurance procedures, including data security, backup and recovery and system controls.

The process also involve testing the programs with both artificial and life data and training the users and the operating personnel.

4.3 PROGRAM MAINTENANCE

This is concerned with whatever changes and enhancement needed to be made after the system is up and running. System maintenance falls into three categories. These are:

(1) Perfective Maintenance: This comprises necessary changes as could be demanded by the users or the programmer. This definitely calls for a review of the system requirement and of course a restructuring of the system design to incorporate the new requirement.

(2) Adaptive Maintenance: Sometimes maintenance is necessary due to the changes in the environment of the program to the new environment. This is what is referred to as adaptive maintenance.

(3) Corrective Maintenance: Program testing and debugging are necessary steps towards perfecting the efficiency and performance of a program. This exercise brings about a number of corrections of undiscovered system errors. This in effect is corrective maintenance.

It is pertinent to note that, it is impossible to produce a system of any size which does not need maintenance. With time, the original requirement of the system will be modified to reflex changing needs; the system environment and even obscured errors which were unidentified during system validation.

Since it is obvious that maintenance is unavoidable, it becomes very necessary for a system designer to place his priority on producing systems which on implementation may have minimal maintenance problems.

CHAPTER FIVE

5.0 ANALYSIS OF RESULT

5.1 RESULT AND ANALYSIS

Three sets of pillars were involved in the analysis of results obtained. These are the perimeter framework pillars, environmental (Lawn) pillars and structural pillars.

From the comparison of results, it was notice that there were large discrepancies in the values of some of the structural pillars (See table 5.3) which makes it look like there was a shift on the structure both in planimetric and height position. This ranges between 1 metre to 38 metres in the Easting, 2 metres to 46 metres in the Northing, while the height are relatively close over the years (1997 – 1999).

But since physical shift up to the tune of this discrepancies was not noticed, this means that something is wrong with the methodology used in collecting data in the previous studies to date. Thereby making it difficult to say that the structure is stable or sinking since the data used for comparison is somehow faulty.

TABLE 5.1 DIFFERENCES ON PERIMETER FRAME WORK PILLARS

PILLAR	EASTING (M)			NORTHING (M)			HEIGHT (M)		
NO	1997/98	1997/99	1998/99	1997/98	1997/99	1998/99	1997/99	1997/98	1998/99
BMSC 301	0.004	0.233	0.229	-0.020	0.017	0.037	0.093	-0.006	-0.099
" 302	0.012	0.202	0.214	-0.048	0.029	0.077	0.009	-0.013	-0.022
303	0.010	0.226	0.236	-0.044	0.002	0.046	0.011	0.009	0.020
304	0.008	0.201	0.209	-0.094	-0.047	0.047	0.013	0.010	0.023
311			0.152			0.006			-4.586
312			0.130			0.033			-4.636
313			0.158			0.106			-4.631
314			0.175			0.125			-3.422
315			0.200			0.083			-1.323

TABLE 5.2 DIFFERENCES ON ENVIRONMENTAL (LAWN) PILLARS

PILLAR	EASTING (M)			NORTHING (M)			HEIGHT (M)		
NO	1997/98	1997/99	1998/99	1997/98	1997/99	1998/99	1997/99	1997/98	1998/99
BMS 201	0.043	0.148	0.105	-0.012	0.015	0.027	-0.395	0.009	0.404
" 202	0.027	0.197	0.170	-0.025	0.026	0.051	0.398	0.006	0.404
203	0.026	0.181	0.155	-0.010	0.026	0.036	-0.394	0.010	0.404
204	0.034	0.191	0.157	-0.022	0.005	0.027	-0.336	0.066	0.402
205	0.049	0.208	0.159	-0.029	-0.001	0.028	-0.337	0.065	0.402
206	0.057	0.207	0.150	-0.027	-0.017	0.010	-0.335	0.070	0.405
207	0.062	0.193	0.131	-0.042	-0.015	0.027	-0.338	0.067	0.405
208	0.073	0.249	0.176	-0.093	-0.015	0.078	-0.336	0.067	0.403
209	0.077	0.238	0.161	-0.073	-0.001	0.072	-0.336	0.066	0.402

TABLE 5.3 DIFFERENCES ON STRUCTURAL PILLARS

PILLAR	EASTING (M)			NORTHING (M)			HEIGHT (M)		
NO	1997/98	1997/99	1998/99	1997/98	1997/99	1998/99	1997/99	1997/98	1998/99
BMS 101	-0.943	1.449	2.392	0.135	46.439	46.304	0.024	0.020	0.004
" 102	-0.457	0.180	0.637	0.380	0.000	0.380	0.023	0.004	0.019
103	-0.407	38.121	37.121	0.194	33.435	33.241	0.033	0.015	0.018
104	0.594	0.073	- 0.521	0.345	2.209	2.554	-0.328	0.215	0.543
105	0.583	0.220	- 0.220	0.309	-0.041	0.268	-0.055	-0.077	0.022
106	-0.765	10.276	- 9.511	0.295	6.399	6.104	0.034	0.024	0.010
107	-0.166	10.281	10.447	0.734	-3.712	-2.978	0.054	-0.043	0.097
108	-0.666	0.271	- 0.391	0.206	-0.015	0.191	0.004	0.014	0.010
					-				

5.2 CONCLUSION

The recent investigation has shown that data processing for deformation studies was not only laborious but in addition, could not meet up with the increasing volume of data for the studies.

The delay in getting the results, uncertainty of their authenticity, etc were enough reasons to think of a more reliable information resource.

Conclusively, from the outcome of this work, it is evident that the system provides a qualitative and more reliable results that could easily be accessed. This makes the whole exercise simple, faster and reliable.

5.3 RECOMMENDATION

Deformation studies should be incorporated into the general practical and project work of the surveying students of the Institution so that this project package will be of use to the school.

Furthermore, it will enhance the safety of lives and properties including those being monitored.

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BADMUS (1999) - Unpublished lecture note on System Analysis and Design.

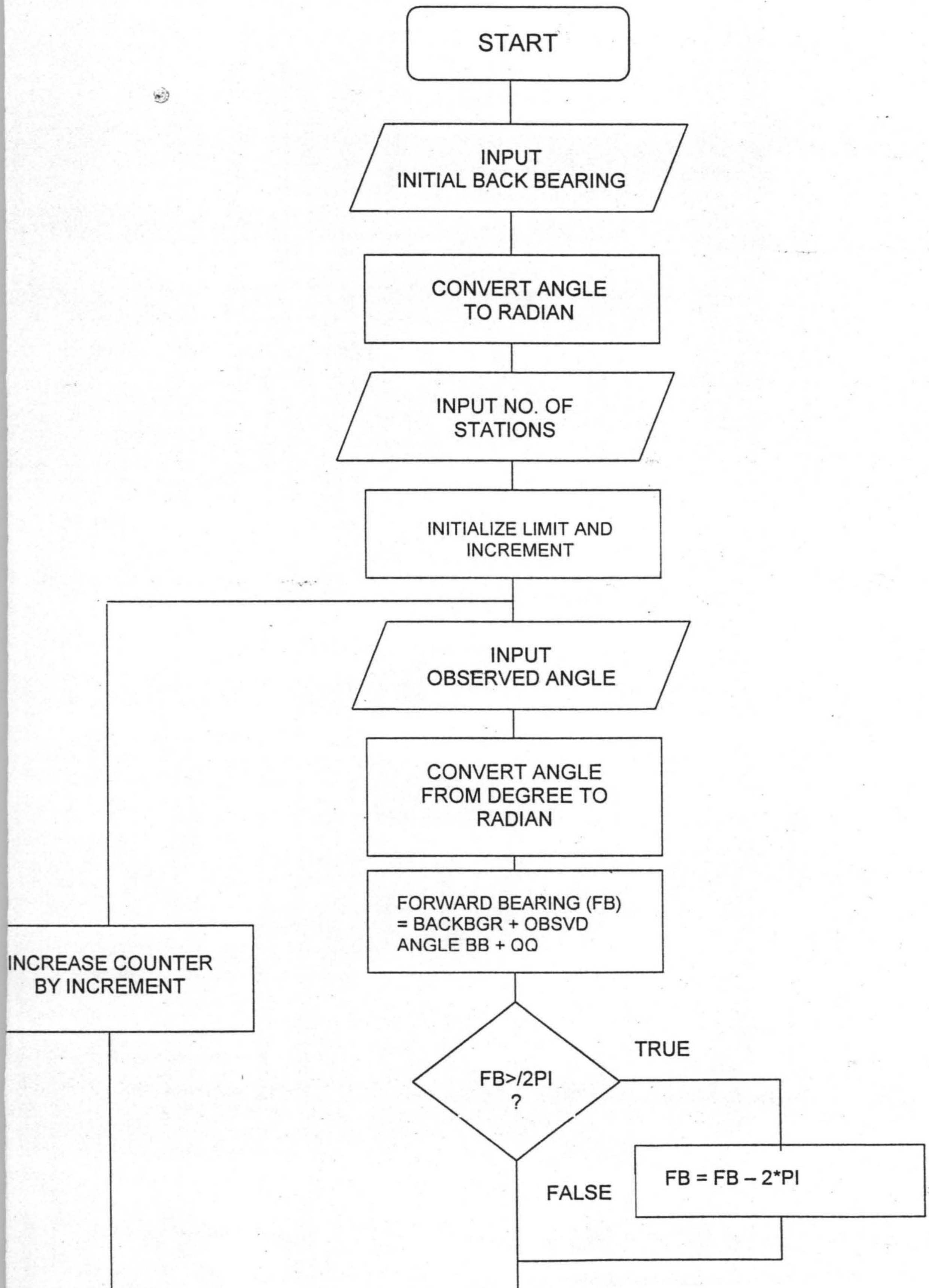
RAHEEM A.K (1999) Deformation studies of the School Library And the new office complex. (Unpublished Project work, F.S.S Oyo)

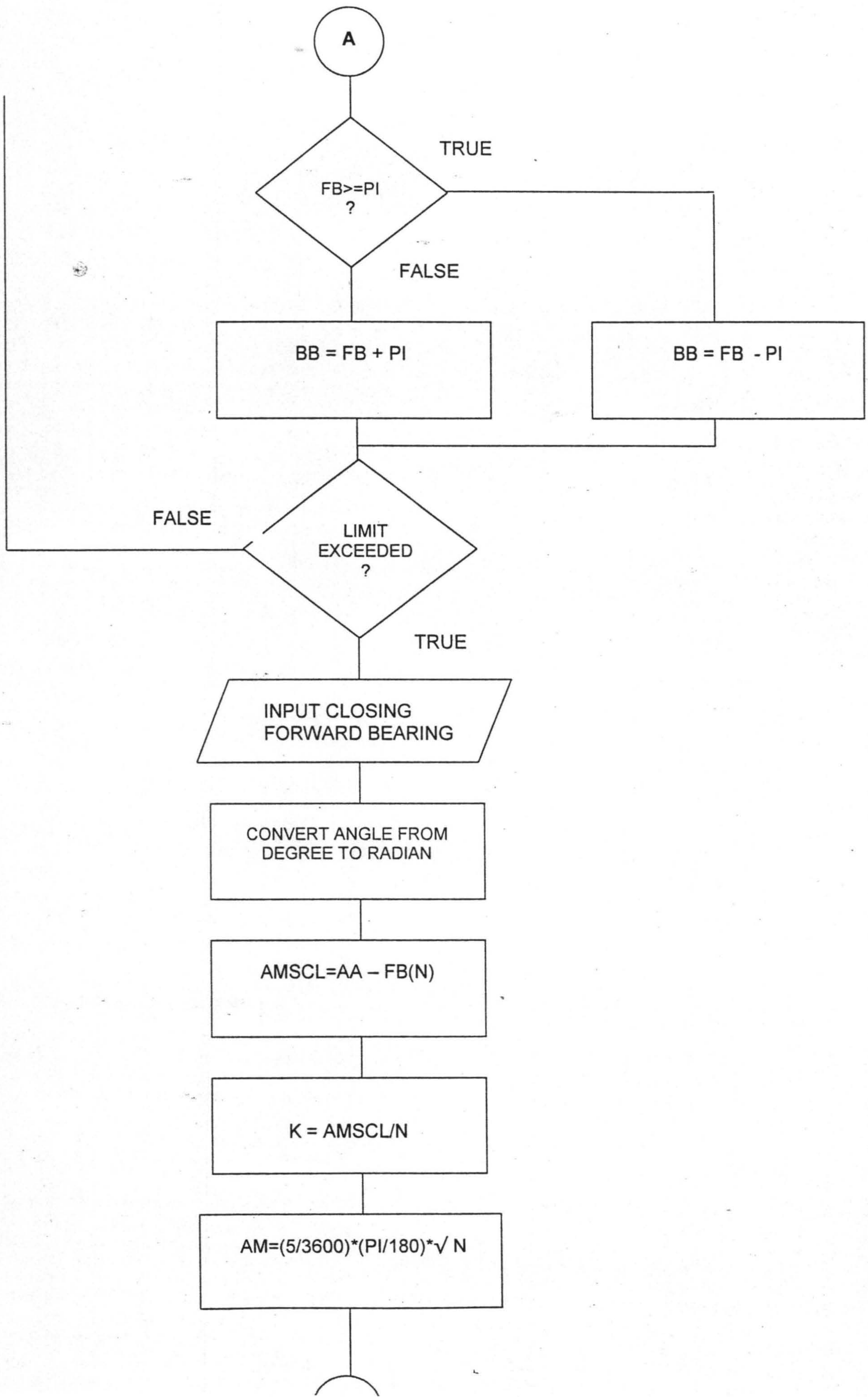
UDABOR G.A (1988) - Provision of Geodetic Infrastructure for Monitoring absolute deformation of the National Arts Theatre and its environs at Iganmu, Lagos (Unpublished M.Sc. Research project of the Dept. of Surv. UNILAG)

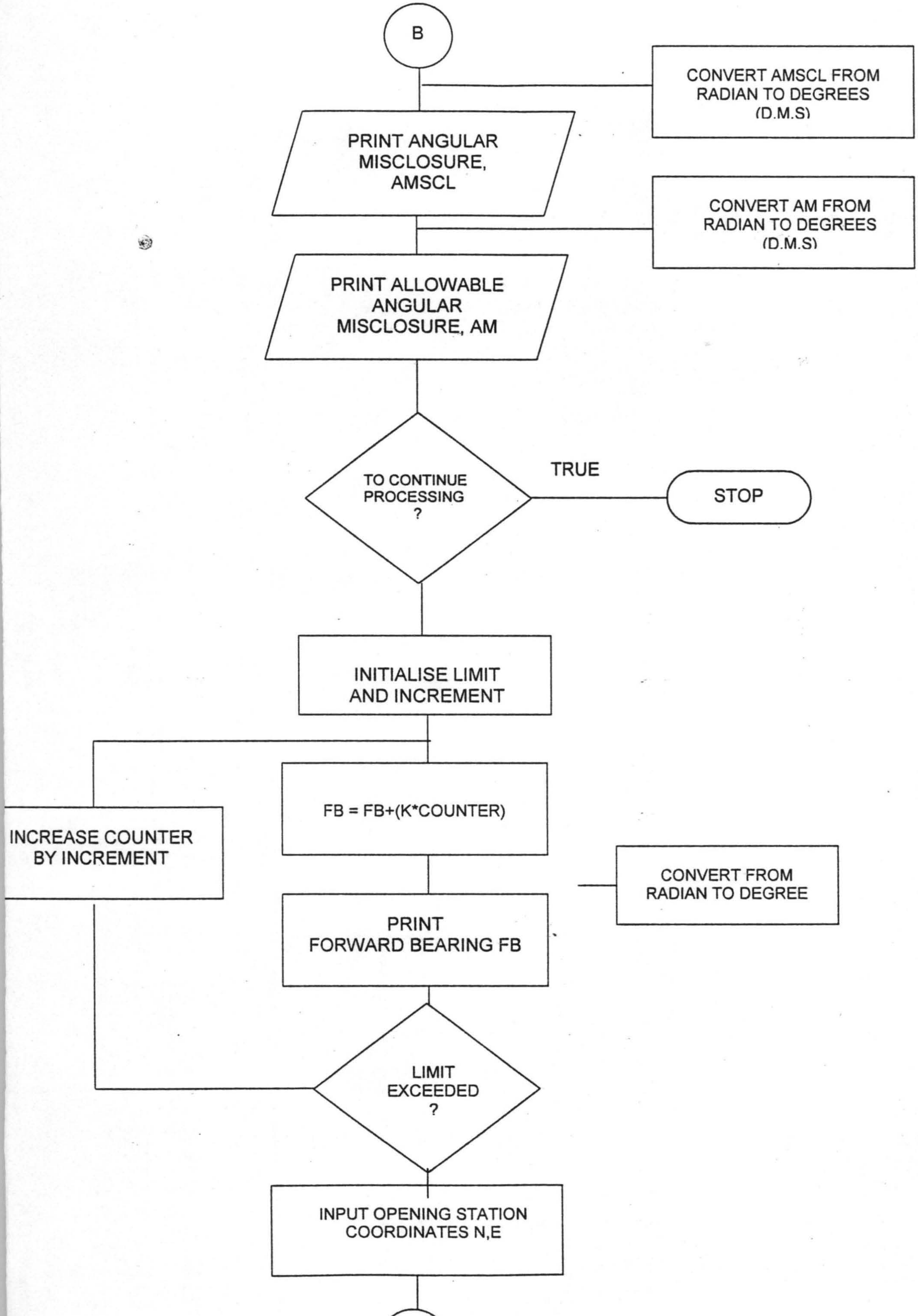
APPENDIX

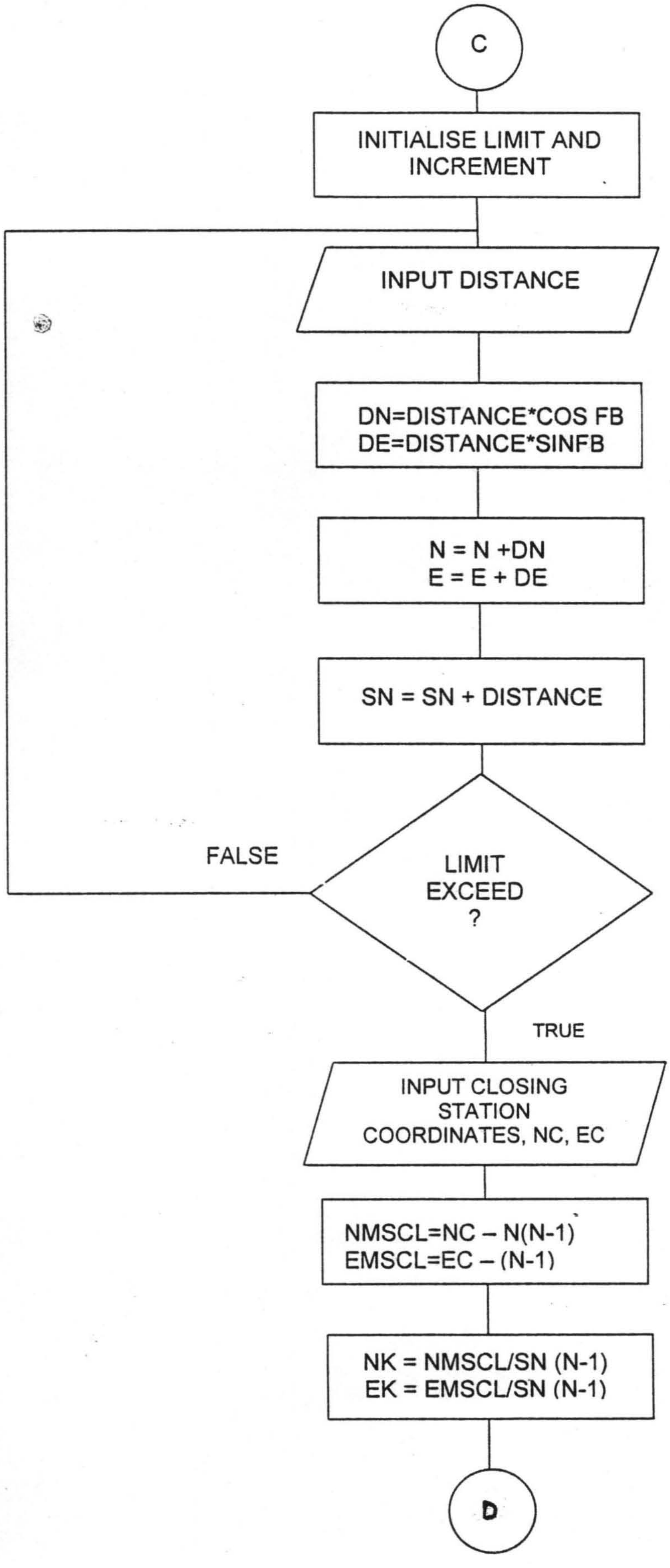
STAGE ONE

TRAVERSE COMPUTATION

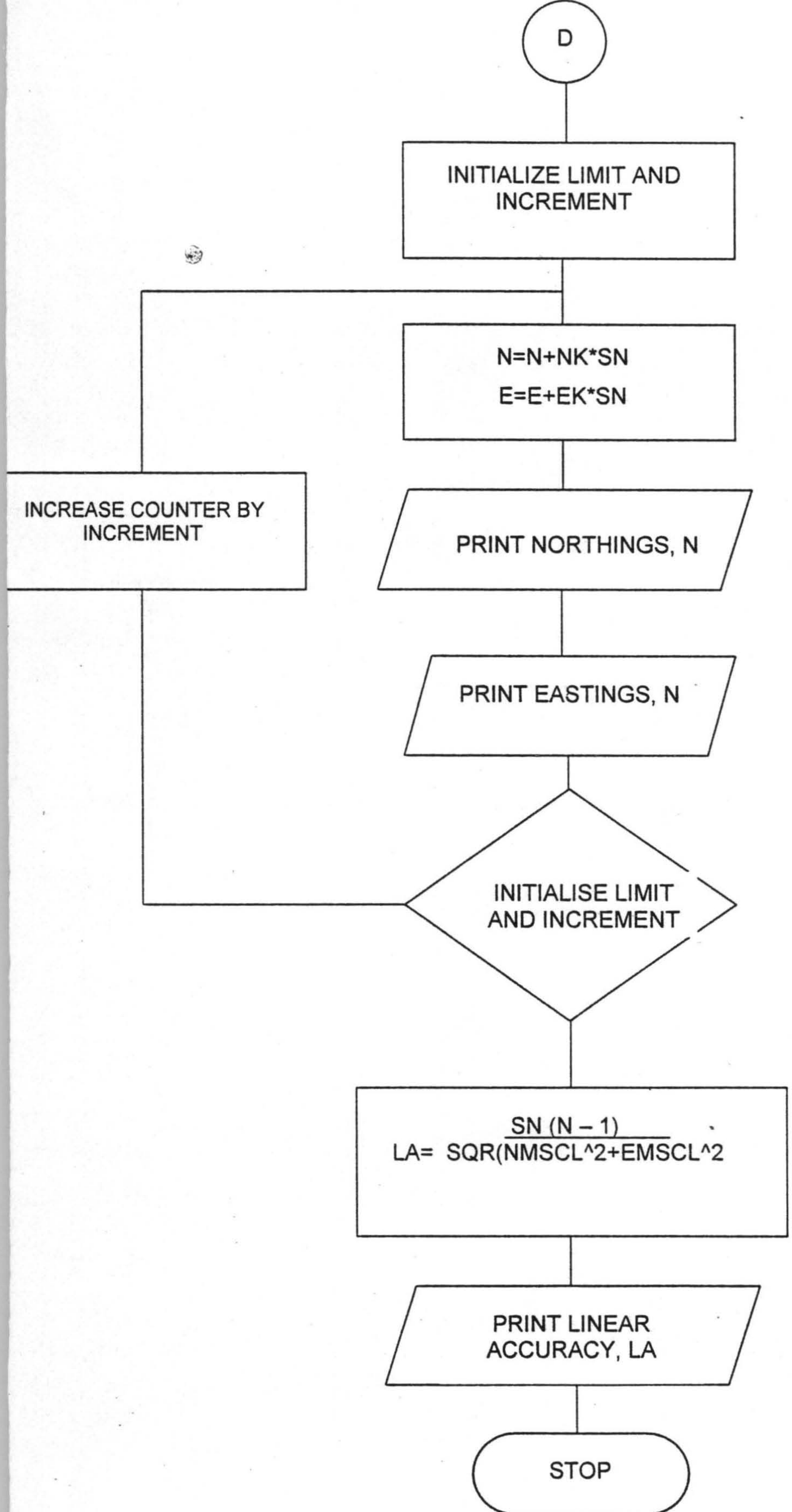



A
TRUE
FB>=PI
?
FALSE
BB = FB + PI
BB = FB - PI
FALSE
LIMIT
EXCEEDED
?
TRUE
INPUT CLOSING
FORWARD BEARING
CONVERT ANGLE FROM
DEGREE TO RADIAN
AMSCL=AA – FB(N)
K = AMSCL/N
AM=(5/3600)*(PI/180)*√ N


B
CONVERT AMSCL FROM RADIAN TO DEGREES (D.M.S)
PRINT ANGULAR MISCLOSURE, AMSCL
CONVERT AM FROM RADIAN TO DEGREES (D.M.S)
PRINT ALLOWABLE ANGULAR MISCLOSURE, AM
TO CONTINUE PROCESSING ?
TRUE
STOP
INITIALISE LIMIT AND INCREMENT
FB = FB+(K*COUNTER)
INCREASE COUNTER BY INCREMENT
CONVERT FROM RADIAN TO DEGREE
PRINT FORWARD BEARING FB
LIMIT EXCEEDED ?
INPUT OPENING STATION COORDINATES N,E



C
INITIALISE LIMIT AND INCREMENT
INPUT DISTANCE
DN=DISTANCE*COS FB
DE=DISTANCE*SINFB
N = N +DN
E = E + DE
SN = SN + DISTANCE
FALSE
LIMIT EXCEED ?
TRUE
INPUT CLOSING STATION COORDINATES, NC, EC
NMSCL=NC – N(N-1)
EMSCL=EC – (N-1)
NK = NMSCL/SN (N-1)
EK = EMSCL/SN (N-1)
D

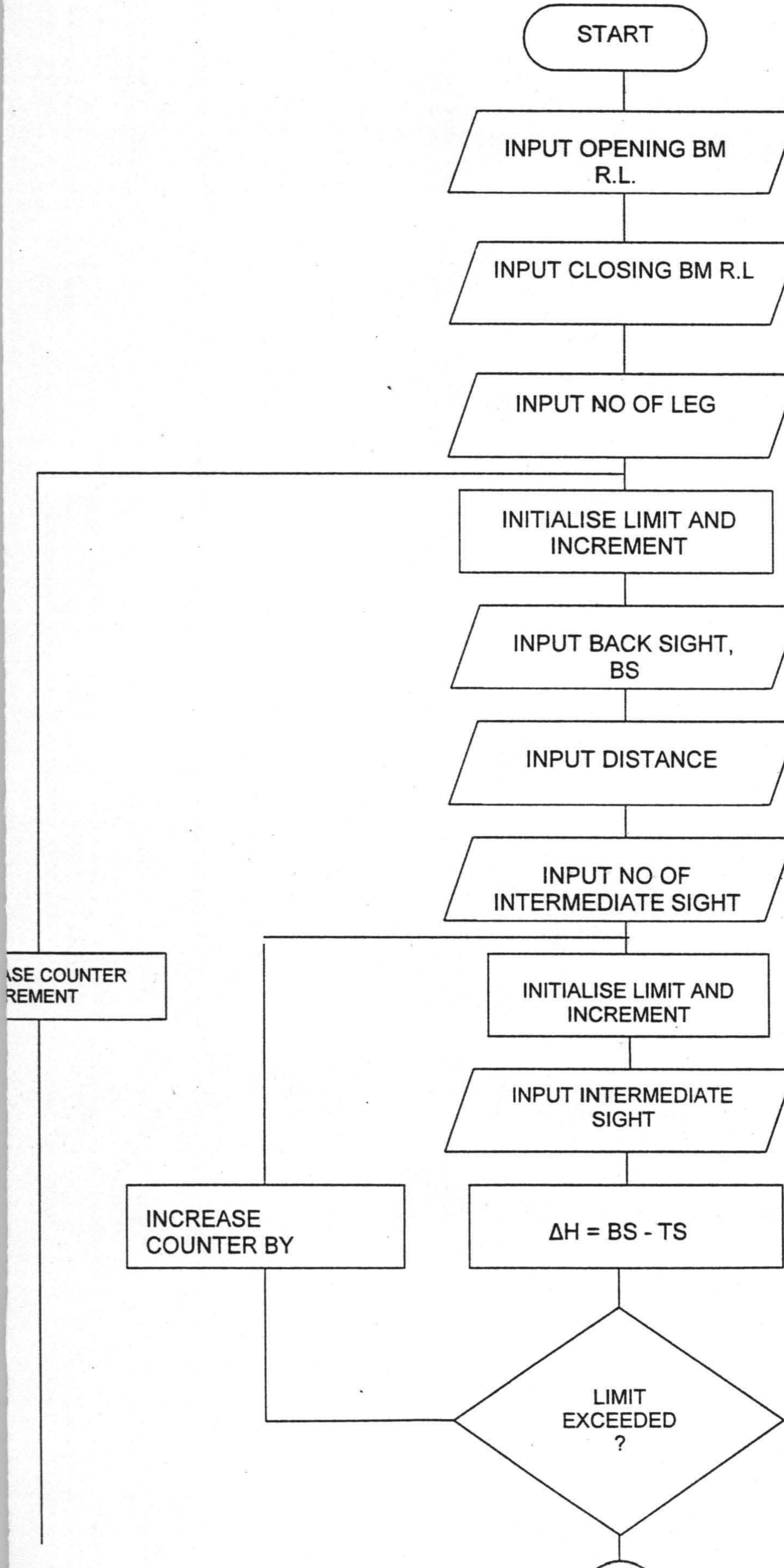

D
INITIALIZE LIMIT AND INCREMENT
N=N+NK*SN
E=E+EK*SN
INCREASE COUNTER BY INCREMENT
PRINT NORTHINGS, N
PRINT EASTINGS, N
INITIALISE LIMIT AND INCREMENT
SN (N – 1)
LA= SQR(NMSCL^2+EMSCL^2
PRINT LINEAR ACCURACY, LA
STOP

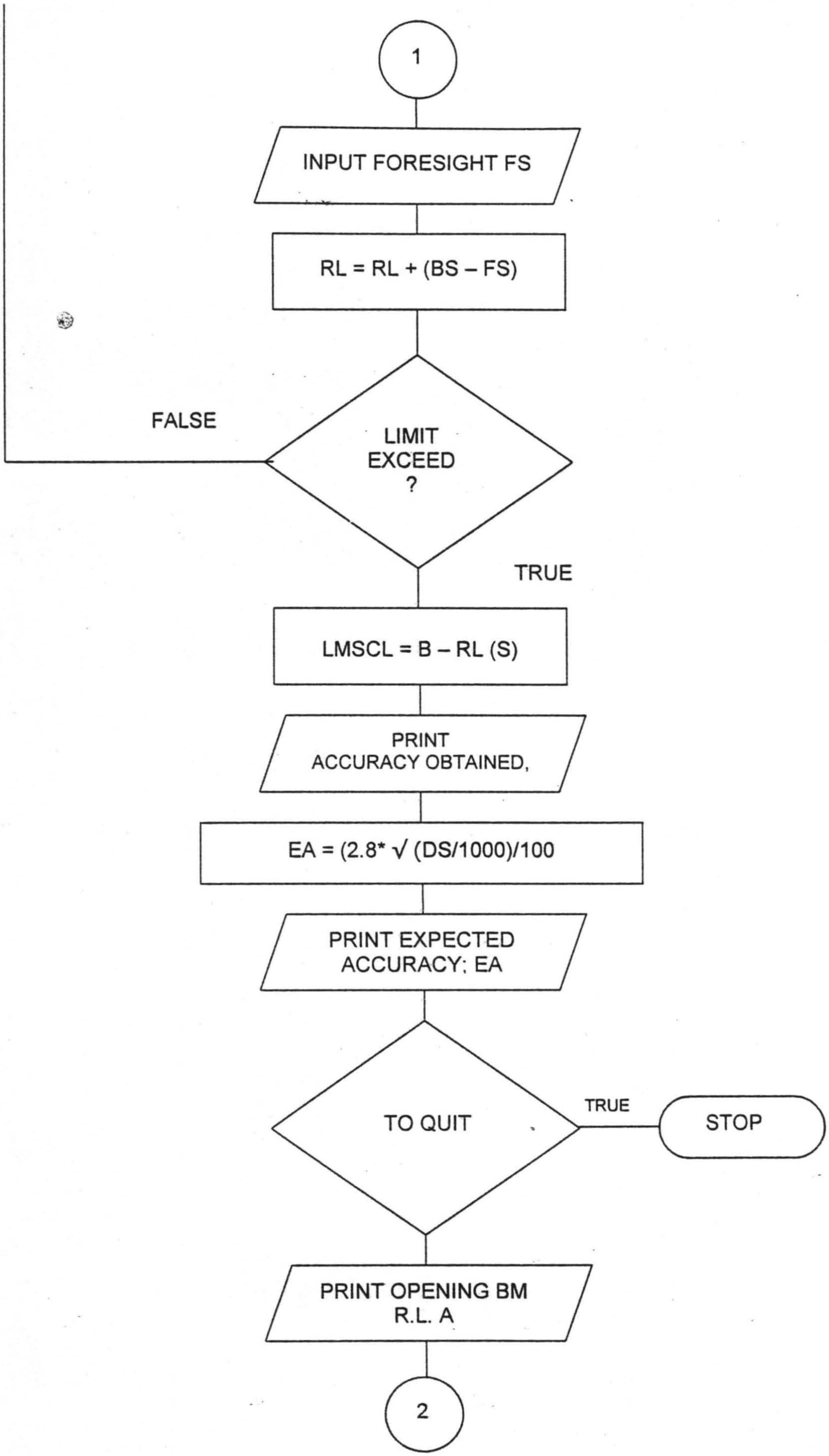
```
CLS
PI = 3.141592654#
INPUT "INITIAL BACK BEARING(B1,B2,B2)"; B1, B2, B3
BB = (B1 + B2 / 60 + B3 / 3600) * PI / 180
INPUT "NO OF STATIONS"; SN
DIM DIST(SN - 1), FB(SN), E(SN - 1), N(SN - 1)
FOR I = 1 TO SN
 INPUT "OBSERVED ANGLE(Q1,Q2,Q3)"; Q1, Q2, Q3
 OA(I) = (Q1 + Q2 / 60 + Q3 / 3600) * PI / 180
 FB(I) = BB + OA(I)
  IF FB(I) >= 2 * PI THEN
  FB(I) = FB(I) - 2 * PI
  END IF
 IF FB(I) >= PI THEN
  BB = FB(I) - PI
         ELSE BB = FB(I) + PI
  END IF
NEXT I
FOR I = 1 TO SN
XX = FB(I) * 180 / PI
U = INT(XX)
U1 = (XX - U) * 60
U2 = INT(U1)
U3 = (U1 - U2) * 60
PRINT "CALCULATED FWD. BRG.", I, "="; U; U2; U3
NEXT I
INPUT "CLOSING FWD. BRG."; A1, A2, A3
AA = (A1 + A2 / 60 + A3 / 3600) * PI / 180
IF AA < FB(SN) THEN
    MSCL = FB(SN) - AA: V = -1
  ELSE MSCL = AA - FB(SN): V = 1
END IF
XX = (MSCL) * 180 / PI
CK = MSCL / SN
U = INT(XX)
U1 = (XX - U) * 60
U2 = INT(U1)
U3 = (U1 - U2) * 60
PRINT "ANGULAR MISCLOSURE="; V, U; U2; U3
AMSCL = 5 / 3600 * (PI / 180) * SQR(SN)
XX = AMSCL * 180 / PI
U = INT(XX)
U1 = (XX - U) * 60
U2 = INT(U1)
U3 = (U1 - U2) * 60
PRINT "ALLOWABLE MISCLOSURE="; U, U2, U3
INPUT "TO CONTINUE PROCESSING ?(Y/N)"; G$

IF G$ = "N" THEN 580
PRINT "S/NO", "CORRECTED FWD.BRG"
PRINT
FOR I = 1 TO SN
FB(I) = FB(I) + (CK * I * V)
XX = FB(I) * 180 / PI
U = INT(XX)
U1 = (XX - U) * 60
U2 = INT(U1)
U3 = (U1 - U2) * 60
PRINT I, U; U2; U3: PRINT
NEXT I
INPUT "OPENING STATION  COORDINATES (N,E)"; NO, EO
PRINT : PRINT
INPUT "CLOSING STATION COORDINATES(N,E)"; NC, EC
```

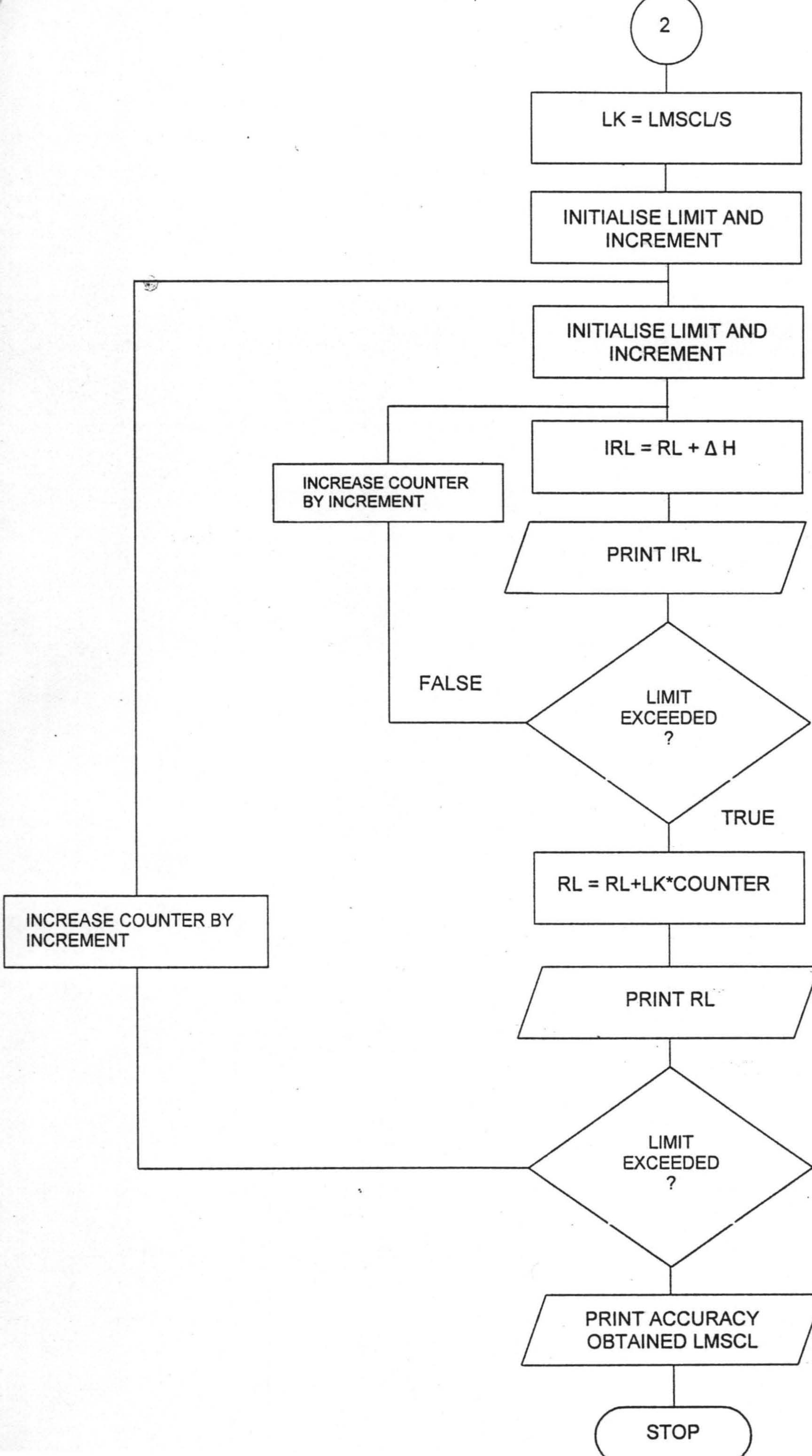
```
INPUT "CORRECTED DISTANCE"; DIST(I)
DN(I) = DIST(I) * COS(FB(I))
PRINT "DN="; DN(I)
DE(I) = DIST(I) * SIN(FB(I))
PRINT "DE="; DE(I)
DSUM(I) = DSUM(I) + DIST(I)
N(I) = NO + DN(I): E(I) = EO + DE(I)
PRINT
PRINT "UNCORRECTED COORD.="; N(I), E(I)
NO = N(I): EO = E(I)
NEXT I
REM CORRECTION FOR THE FINAL COORDINATES
IF NC < NO THEN
  KN = NO - NC: X = -1
  ELSE KN = NC - NO: X = 1
END IF
IF EC < EO THEN
  KE = EO - EC: Z = -1
  ELSE KE = EC - EO: Z = 1
END IF
PRINT "NORTHING MSCL="; KN: PRINT
PRINT "EASTING MSCL.="; KE: PRINT
PRINT "TOTAL DISTANCE="; DSUM(SN - 1): PRINT
F = KN / DSUM(SN - 1): G = KE / DSUM(SN - 1)
FOR I = 1 TO (SN - 1)
N(I) = N(I) + F * X * INT(DSUM(I))
E(I) = E(I) + G * Z * INT(DSUM(I))
NEXT I
PRINT TAB(11); "NORTHING(m)"; TAB(28); "EASTING(m)"
FOR I = 1 TO SN - 1
PRINT TAB(12); , USING "########.###"; N(I);
PRINT TAB(28); , USING "########.###"; E(I)
NEXT I
H = DSUM(SN - 1) / SQR(KN ^ 2 + KE ^ 2)
J = INT(H)
PRINT : PRINT
PRINT TAB(29); "TOTAL DISTANCE =", DSUM(SN - 1)
PRINT
PRINT TAB(29); "LINEAR ACCURACY =", J
STOP
```

STAGE II

LEVELLING COMPUTATION



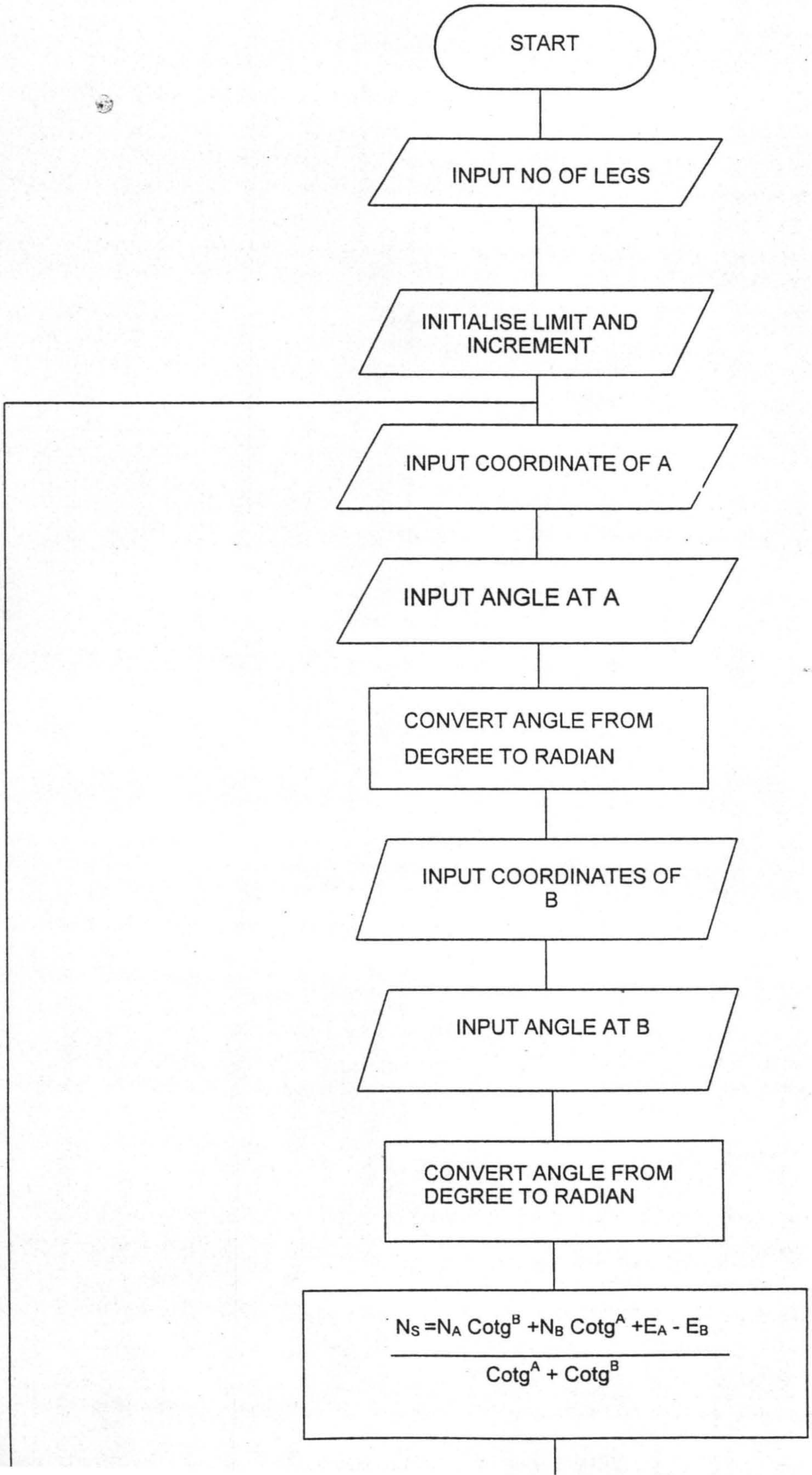

1
INPUT FORESIGHT FS
RL = RL + (BS – FS)
FALSE
LIMIT EXCEED ?
TRUE
LMSCL = B – RL (S)
PRINT ACCURACY OBTAINED,
EA = (2.8* √ (DS/1000)/100
PRINT EXPECTED ACCURACY; EA
TO QUIT
TRUE
STOP
PRINT OPENING BM R.L. A
2

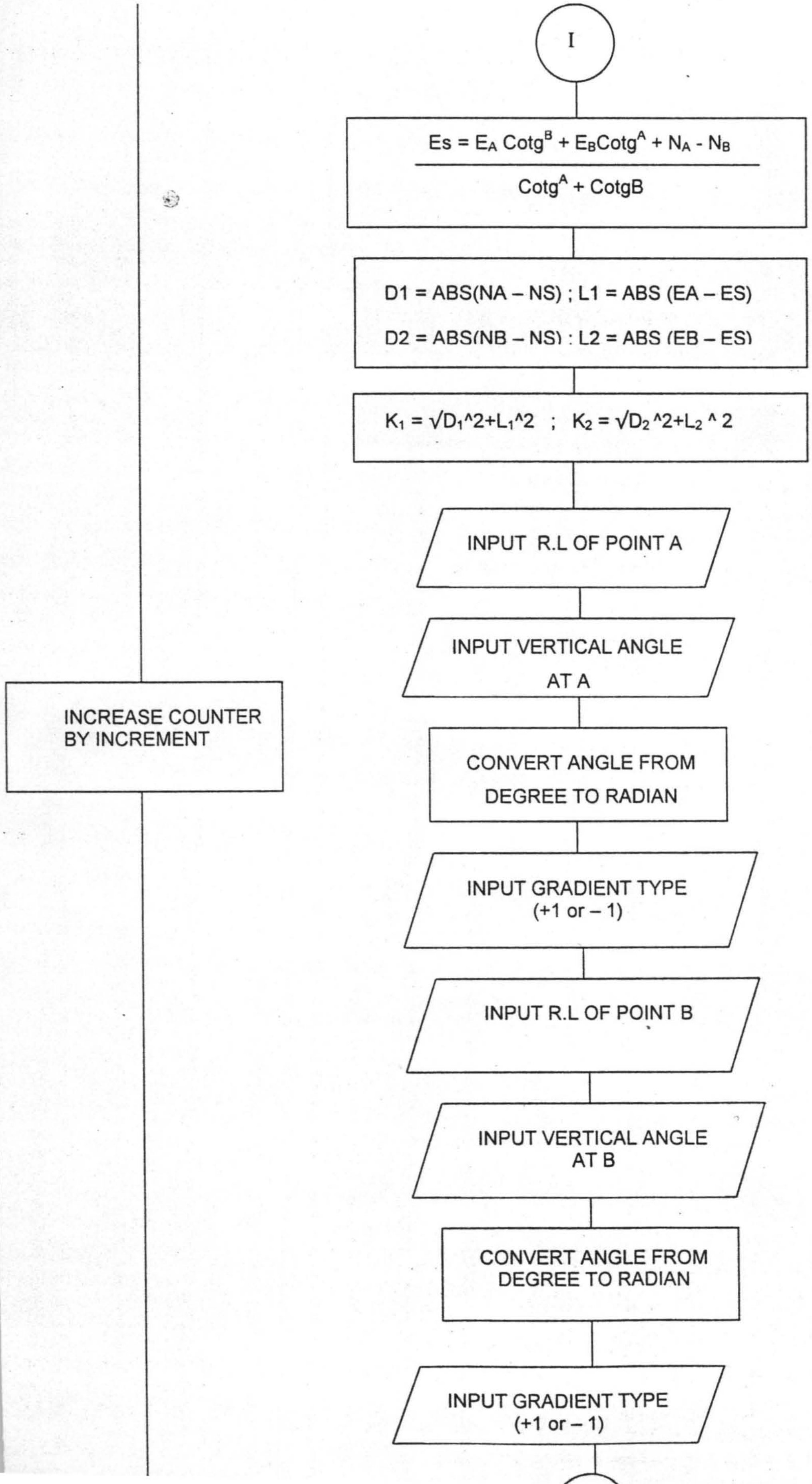

2
LK = LMSCL/S
INITIALISE LIMIT AND INCREMENT
INITIALISE LIMIT AND INCREMENT
IRL = RL + Δ H
INCREASE COUNTER BY INCREMENT
PRINT IRL
FALSE
LIMIT EXCEEDED ?
TRUE
RL = RL+LK*COUNTER
INCREASE COUNTER BY INCREMENT
PRINT RL
LIMIT EXCEEDED ?
PRINT ACCURACY OBTAINED LMSCL
STOP

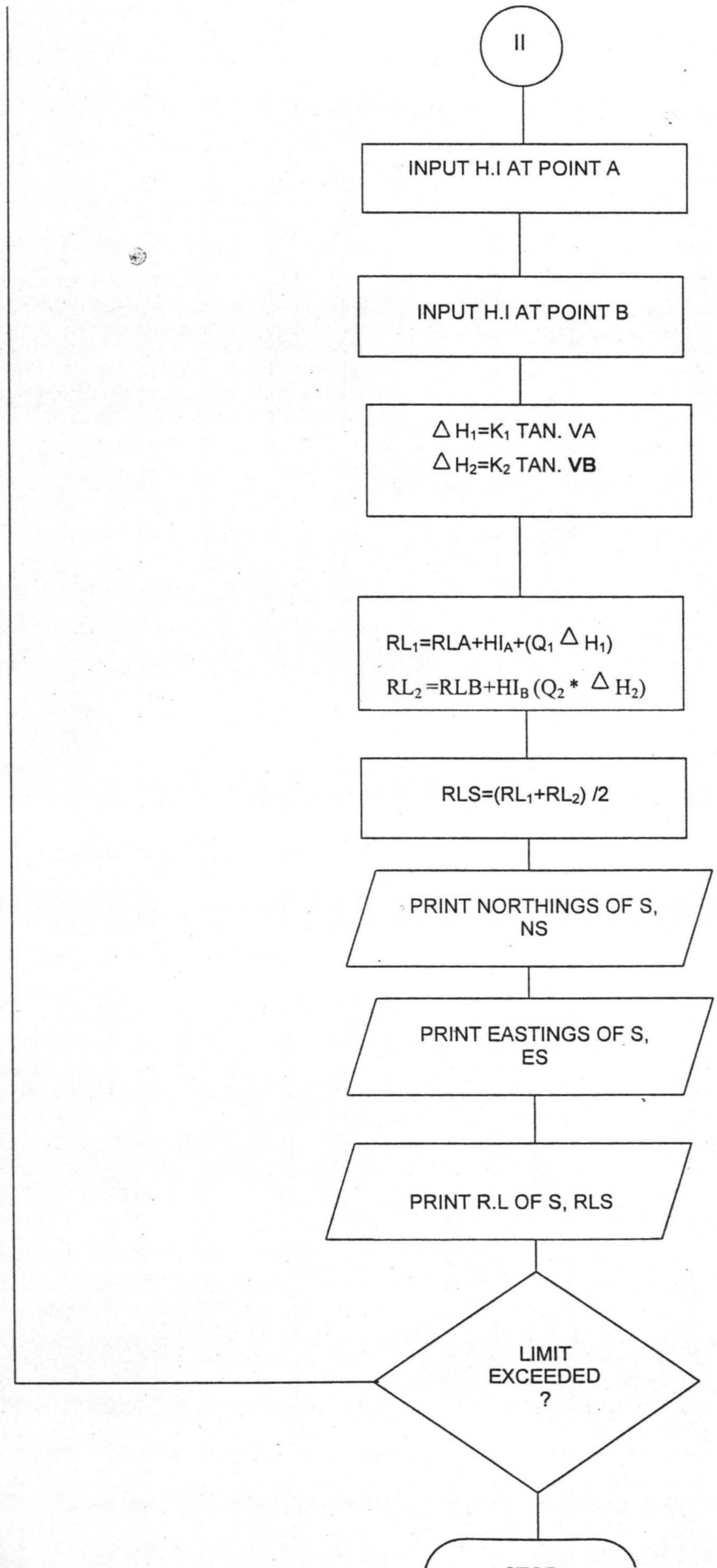
```
REM  LEVELLING COMPUTATION
CLS:SAVE"levcom.bas
INPUT "INPUT OPENING STATION REDUCED LEVEL          ", RL
PRINT
INPUT "INPUT CLOSING STATION REDUCED LEVEL          ", CL
PRINT
INPUT "INPUT NO OF LEGS ", S: AA = RL
PRINT
FOR I = 1 TO S
  INPUT "INPUT BACK SIGHT                           ", BS(I)
 PRINT
  INPUT "INPUT DISTANCE                             ", DIST(I)
 PRINT
  INPUT "INPUT NO OF INTERMEDIATE SIGHT(S)          ", Q
 PRINT
  FOR K = 1 TO Q
   INPUT "INPUT INTERMEDIATE SIGHT                  ", XS(K)
PRINT
   DH(K) = BS(I) - XS(K)
  NEXT K
  INPUT "INPUT FORE-SIGHT  ", FS(I)
  RL(I) = RL + (BS(I) - FS(I)): RL = RL(I)
  DSUM(I) = DSUM + DIST(I): DSUM = DSUM(I)
NEXT I
LMSCL = CL - RL(S)
PRINT "ACCURACY  OBTAINED =   "; LMSCL: PRINT
EA = (2.8 * SQR(DSUM(S) / 1000)) / 100
PRINT "ACCURACY  EXPECTED =   "; EA: PRINT
INPUT "TO CONTINUE THE PROCESSING ? (Y/N)", G$
IF G$ = "N" THEN GOTO 380
PRINT TAB(20); "REDUCED  LEVEL (m) "
PRINT TAB(24); AA
LK = LMSCL / S
FOR I = 1 TO S
  FOR K = 1 TO Q
   IRL(K) = RL + DH(K)
   PRINT TAB(24); IRL(K)
  NEXT K
  RL(I) = RL(I) + (LK * I)
  PRINT TAB(24); RL(I)
NEXT I
PRINT : PRINT : PRINT
PRINT "ACCURACY  OBTAINED  =   "; LMSCL
STOP
```

STAGE III

RESECTION COMPUTATION (STRUCTURAL POINT COORDINATION & HEIGHTING




I
Es = E_A $Cotg^B$ + $E_B$$Cotg^A$ + N_A - N_B
$Cotg^A$ + CotgB
D1 = ABS(NA – NS) ; L1 = ABS (EA – ES)
D2 = ABS(NB – NS) ; L2 = ABS (EB – ES)
K_1 = √D_1^2+L_1^2 ; K_2 = √D_2^2+L_2 ^ 2
INPUT R.L OF POINT A
INPUT VERTICAL ANGLE AT A
CONVERT ANGLE FROM DEGREE TO RADIAN
INPUT GRADIENT TYPE (+1 or – 1)
INPUT R.L OF POINT B
INPUT VERTICAL ANGLE AT B
CONVERT ANGLE FROM DEGREE TO RADIAN
INPUT GRADIENT TYPE (+1 or – 1)
INCREASE COUNTER BY INCREMENT


II
INPUT H.I AT POINT A
INPUT H.I AT POINT B
$\Delta H_1=K_1$ TAN. VA
$\Delta H_2=K_2$ TAN. **VB**
$RL_1=RLA+HI_A+(Q_1 \Delta H_1)$
$RL_2=RLB+HI_B (Q_2 * \Delta H_2)$
$RLS=(RL_1+RL_2) /2$
PRINT NORTHINGS OF S, NS
PRINT EASTINGS OF S, ES
PRINT R.L OF S, RLS
LIMIT EXCEEDED ?

```
REM  INTERSECTION  COMPUTATION
CLS : PI = 3.141592654#
PRINT TAB(16); "INTERSECTION COMPUTAION FOR STRUCTURAL PILLARS"
PRINT TAB(14); "=================================================="
PRINT
T = OPENOUT("NORTINGS OUT")
Y = OPENOUT("EASTINGS OUT")
U = OPENOUT("HEIGHTS OUT")
INPUT "INPUT NO OF POINT(S) TO COMPUTED     ", S: PRINT
FOR I = 1 TO S
INPUT "INPUT COORDINATE OF A (N,E)        "; NA(I), EA(I): PRINT
INPUT "INPUT ANGLE AT  A  (D,M,S)         "; A1, A2, A3: PRINT
A(I) = (A1 + A2 / 60 + A3 / 3600) * PI / 180
INPUT "INPUT COORDINATE OF B (N,E)         "; NB(I), EB(I): PRINT
INPUT "INPUT ANGLE AT B (D,M,S)            "; B1, B2, B3: PRINT
B(I) = (B1 + B2 / 60 + B3 / 3600) * PI / 180
F(I) = COS(A(I)) / SIN(A(I))
IF F(I) < 0 THEN
  W = (-1)
  ELSE W = 1
END IF
G(I) = COS(B(I)) / SIN(B(I))
IF G(I) < O THEN
  V = (-1)
   ELSE V = 1
END IF

NS(I) = (NA(I) * G(I) + NB(I) * F(I) + (EA(I) - EB(I))) / (F(I) + G(
ES(I) = (EA(I) * G(I) + EB(I) * F(I) + (NA(I) - NB(I))) / (F(I) + G(
D1 = ABS(NA(I) - NS(I)): L1 = ABS(EA(I) - ES(I))
D2 = ABS(NB(I) - NS(I)): L2 = ABS(EB(I) - ES(I))
K1 = SQR(D1 ^ 2 + L1 ^ 2): K2 = SQR(D2 ^ 2 + L2 ^ 2)
INPUT "INPUT REDUCED LEVEL OF POINT A    "; ARL(I): PRINT
INPUT "INPUT HEIGHT OF INSTRUMENT AT  A"; AHI(I): PRINT
INPUT "INPUT VERTICAL ANGLE AT 'A' (D,M,S) "; M1, M2, M3: PRINT
VA(I) = (M1 + M2 / 60 + M3 / 3600) * PI / 180
INPUT "INPUT THE GRADIENT TYPE (POSITIVE OR NEGATIVE ?)"; SG$: PRINT
IF SG$ = "POSITVE" THEN
  AQ = 1
    ELSE AQ = (-1)
END IF
INPUT "INPUT REDUCED LEVEL OF POINT 'B'  "; BRL(I): PRINT
INPUT "INPUT HEIGHT OF INSTRUMENT AT 'B'"; BHI(I): PRINT
INPUT "INPUT VERTICAL ANGLE AT 'B'(D,M,S) "; N1, N2, N3: PRINT
VB(I) = (N1 + N2 / 60 + N3 / 3600) * PI / 180
INPUT "INPUT GRADIENT TYPE (POSITIVE OR NEGATIVE ?)"; CG$: PRINT
IF CG$ = "POSITIVE" THEN
  BQ = 1
   ELSE BQ = (-1)
END IF
DH1(I) = K1 * TAN(VA(I)): DH2(I) = K2 * TAN(VB(I))
RL1(I) = ARL(I) + AHI(I) + (AQ * DH1(I))
RL2(I) = BRL(I) + BHI(I) + (BQ * DH2(I))
RLS(I) = (RL1(I) + RL2(I)) / 2
NEXT I
PRINT #T, TAB(14); "NORTHINGS (metre)": PRINT
PRINT #Y, TAB(14); "EASTING  (metres)": PRINT
PRINT #U, TAB(14); "REDUCED LEVEL (m)": PRINT
CLOSE #T: CLOSE #Y: CLOSE #U: PRINT
FOR I = 1 TO S
PRINT #T, TAB(16); NS(I)
PRINT #Y, TAB(16); ES(I)
PRINT #U, TAB(18); RLS(I)
```