Perceptions of Curriculum Emphasis: A Pilot Q Sort Study

Olugbenro A. Ajayi
Western Michigan University

Follow this and additional works at: https://scholarworks.wmich.edu/dissertations

Part of the Curriculum and Instruction Commons

Recommended Citation
https://scholarworks.wmich.edu/dissertations/2931

This Dissertation-Open Access is brought to you for free and open access by the Graduate College at ScholarWorks at WMU. It has been accepted for inclusion in Dissertations by an authorized administrator of ScholarWorks at WMU. For more information, please contact maira.bundza@wmich.edu.
PERCEPTIONS OF CURRICULUM EMPHASIS:
A PILOT Q SORT STUDY

by
Olugbenro A. Ajayi

A Dissertation
Submitted to the
Faculty of The Graduate
College in partial fulfillment
of the
Degree of Doctor of Education

Western Michigan University
Kalamazoo, Michigan
December 1974
ACKNOWLEDGEMENTS

I gratefully acknowledge that the research study reported here would not have been possible but for the progressive staff development schemes of my previous and current employers, namely, the Ministry of Education in the Western State of Nigeria Public Service, and the Governing Board of the Polytechnic, Ibadan respectively.

In conducting the research study at a location separated from the Western Michigan University campus by a trans-Atlantic distance of several thousand miles, I have found considerable encouragement in the confidence placed in me by Dr. H. W. Boles, Dr. G. E. Kohrman and Dr. G. G. Mallinson of my doctoral committee. My appreciation also goes to my several colleagues and friends both in Kalamazoo, Michigan and in Ibadan, Nigeria for the assistance they rendered in various ways during the conduct of the study. Lastly, I thank my wife, Olukemi specially for her support, patience and sacrifice throughout the program of studies.

Olugbenro A. Ajayi
INFORMATION TO USERS

This material was produced from a microfilm copy of the original document. While the most advanced technological means to photograph and reproduce this document have been used, the quality is heavily dependent upon the quality of the original submitted.

The following explanation of techniques is provided to help you understand markings or patterns which may appear on this reproduction.

1. The sign or “target” for pages apparently lacking from the document photographed is “Missing Page(s)”. If it was possible to obtain the missing page(s) or section, they are spliced into the film among with adjacent pages. This may have necessitated cutting thru an image and duplicating adjacent pages to insure you complete continuity.

2. When an image on the film is obliterated with a large round black mark, it is an indication that the photographer suspected that the copy may have moved during exposure and thus cause a blurred image. You will find a good image of the page in the adjacent frame.

3. When a map, drawing or chart, etc., was part of the material being photographed the photographer followed a definite method in “sectioning” the material. It is customary to begin photoing at the upper left hand corner of a large sheet and to continue photoing from left to right in equal sections with a small overlap. If necessary, sectioning is continued again — beginning below the first row and continuing on until complete.

4. The majority of users indicate that the textual content is of greatest value, however, a somewhat higher quality reproduction could be made from “photographs” if essential to the understanding of the dissertation. Silver prints of “photographs” may be ordered at additional charge by writing the Order Department, giving the catalog number, title, author and specific pages you wish reproduced.

5. PLEASE NOTE: Some pages may have indistinct print. Filmed as received.

Xerox University Microfilms
300 North Zeib Road
Ann Arbor, Michigan 48106

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
AJAYI, Olugbenro A., 1936-
PERCEPTIONS OF CURRICULUM EMPHASIS:
A PILOT Q SORT STUDY.

Western Michigan University, Ed.D., 1974
Education, general

Xerox University Microfilms, Ann Arbor, Michigan 48106
TABLE OF CONTENTS

LIST OF ILLUSTRATIONS .. .. .. .. .. .. .. .. v

LIST OF TABLES .. .. .. .. .. .. .. .. .. .. vi

CHAPTER

I INTRODUCTION .. .. .. .. .. .. .. .. 1
   General Problem Considerations .. .. .. .. 1
   Specific Problem Considerations .. .. .. .. 9

II RATIONALE .. .. .. .. .. .. .. .. .. 11
   Summary of Theoretical Framework .. .. .. .. 11
   Review of Pertinent Research .. .. .. .. .. .. 13
   Statement of Objective .. .. .. .. .. .. .. 20

III PROCEDURE .. .. .. .. .. .. .. .. .. 22
   General Experimental Design .. .. .. .. .. .. 22
   Experimental Variables .. .. .. .. .. .. 25
   Experimental Treatment .. .. .. .. .. .. 27
   Population And Sample .. .. .. .. .. .. 28
   Data And Instrumentation .. .. .. .. .. .. 30

iii

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
IV CONCLUSIONS ....... 36
Analytical Results ....... 36
General Findings ....... 42
Recommendations For Further Study ....... 44
BIBLIOGRAPHY ....... 48

APPENDICES
A Q Sort Instructions ....... 51
B Frame of Reference Cards ....... 54
C Q Sort Statement Cards ....... 56
D Q Board ....... 64
E Q Sort Raw Data Sheet ....... 66
F Feedback Cards ....... 68
G Supplementary List of High Priority Items Identified ....... 72
H Illustrative Example - Related Sciences for Engineering Technology Programs ....... 78
I Illustrative Example - Construction Technology ....... 85
J Illustrative Example - Electrical Engineering Technology ....... 99
K Illustrative Example - Mechanical Engineering Technology ....... 114

iv

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
# LIST OF ILLUSTRATIONS

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>DESCRIPTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bloom's Model and the Process Model</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Q Board</td>
<td>65</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Measures of Perception Congruence</td>
<td>36</td>
</tr>
<tr>
<td>2 Measures of Perception Change</td>
<td>40</td>
</tr>
<tr>
<td>3 Illustrative Examples of the Application of Q Sorts to Curriculum Development</td>
<td>47</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

General Problem Considerations

Definitions

There is no uniformity in practice, in the use of such terms as 'curriculum', 'course content' and 'syllabus'. In this study, the term 'curriculum' will be used to cover course content and to describe the sum total of a planned sequence of learning experiences. It is recognised that the student learns a great deal outside the areas for which conscious plans are laid, but the term 'curriculum' will be used only for the activities over which teaching staff try to exercise direction. Some of the planned experiences or opportunities will be 'informal' and 'unstructured', but if they are introduced or moderated in any form, they should be regarded as contributing to the curriculum. On the other hand, the term syllabus is usually used for a list of subjects or an analysis of a knowledge area.

Models

In discussing systems approaches to accountability in education, it is often stressed that the concept of accountability implies a process for measuring program output against stated objectives; and furthermore, that accountability implies cost effectiveness. For purposes of illustration, educational program output is usually

1

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
defined in terms of goals, objectives and subject-matter content on the one hand, and orderly opinion as to relative emphasis on the other hand. Although goals, objectives and subject-matter content are involved in any given teaching-learning situation, the relative emphasis placed upon them varies considerably. These emphases differ not only between courses but also between teachers giving the same course and between students taking the same course from the same teacher.

Subject-matter content usually receives the greatest emphasis, because courses are normally described and discussed in terms of their syllabi. The weakness of this technique is that it lists the topics to be covered but gives little indication of the level at which any particular piece of content is expected to be understood or even applied. For this reason, decisions which are regarded as content decisions may in reality be decisions about the balance between subject-matter content and various kinds of objectives. The breadth-depth controversy is an illustrative example. A preference for the treatment of a narrower range of content at a greater depth may express no more than a desire for students to accumulate more information in certain areas so as to acquire 'a critical mass'; but more often, it is an expression on the development of intellectual abilities by giving the student more independent (library or other self-instructional programs) work as well as special projects.

There have been a number of attempts to try and set out classification schemes for educational objectives. None has proved completely adequate and they certainly do not have the status of
formal theories of knowledge but many are of considerable practical use in clarifying ideas about objectives. In particular, they can be useful in building profiles of a curriculum in terms of the different kinds of objectives and to guide decisions about the relative emphases to be placed on the objectives.

The scheme which has received the greatest attention has been the Taxonomy of Educational Objectives compiled by Bloom and others.\(^1\) The taxonomy recognizes three major classes of objectives as the cognitive, the affective and the psychomotor. Classification schemes have been developed for the cognitive and affective domains and these are well known.

MacKenzie et al\(^2\) summarize succinctly a current educational controversy thus:

"Scriven uses a classification scheme rather than a taxonomy and thus avoids the content versus process controversy over whether a curriculum should be based on using intellectual skills to build up an increasing understanding of the content of a discipline, or whether it should concentrate on developing the intellectual skills or process of a discipline and use the content merely as illustrative material or data to be manipulated. Bloom, by developing a taxonomy, emphasizes the build-up of intellectual skills upon appropriate knowledge in a given content area. It is a content-based model but


\(^2\)loc. cit., p. 111-112.
nevertheless one which assigns considerable importance to process objectives. Some recent curricula, however, have considered it more important to emphasize the transfer of intellectual skills from one content area to another within a given field and have developed a process model which places these skills on a separate dimension orthogonal to the content dimension. Both models include an attitudinal dimension (see Fig. 1)."

Latchman and Russell\(^1\) used a simple triangular model in providing some insight into the answers to the fundamental question of "where do objectives come from"? The three areas identified as contributing to the design of a curriculum are the personal needs of the students, the requirements of potential employers and the larger society, as well as the demands of both teachers and the discipline or more precisely subjects which are generally teacher-

\(^1\)Latchman, J. and Russell, T.J. Curriculum Management in Further Education. Further Education Staff College, Coombe Lodge, Blagdon, Bristol, England, March 1974. p. 4 (mimeo.).
created topic groupings, derived for the convenience of teachers. The requirements of employers are expected to have a profound effect on the more vocationally-oriented curricula, while the general implicit requirements of society have more effect on the more broad-based curricula. As a minimum, where the public finances the curriculum, there is the expectation that the output of students who complete the curriculum will be acceptable to the community at large. The vested interests of teachers and subjects reportedly tend to drag in all sorts of topics which have little relevance to the original conception as may have been derived from the other two general sources of curriculum design. The two authors conclude that¹:

"There are many potential sources of conflict in designing a course with three contributory sources of interest, what has to be decided is what is the precedence and difficulties will arise when we fail to maintain the order of precedence."

Relative emphasis

Tanner² summarized his position on preference assignment or relative emphasis as part of orderly opinion as follows:

"The elusive problem of assigning preferences to educational program components is challenging. In total program evaluation it would be helpful to know something about value judgments concerning courses taken by students, with the assumption that

¹Ibid.
these judgments may serve as a guide to what may be expected in future programs. Indeed, assessment of program value by the participants should be a part of program planning. Evaluation as a component of the monitor activity of the systems approach is proposed to improve decisions about program elements. The possible decisions per program may be to improve courses, continue courses without change, or eliminate courses altogether.

At all levels of education there is awareness of a need for updating curriculum content and ascertaining its relevance to changing conditions. There is therefore a tendency to accumulate more material to teach in the fixed time available (that is, a constant volume constraint) and it becomes necessary to fix priorities. Priorities are then usually reflected in the relative emphasis given to the various components of the curriculum content.

Procedure

While planning curriculum for educational programs for entry into some professions and vocations it is common to involve representatives of teachers and various combinations of professional groups, employers, laymen and parents on curriculum committees. Also, it is sometimes urged that students be involved in a constructive manner. Usually, curriculum committees are small groups operating generally in a conference setting with its basic information in written form. However, observation of the operation of the panels or committees which actually determine content and standard suggests that the bulk of the work is usually done by a few individuals, very often the teachers. The result is that a few teachers (hopefully capable and
experienced) are in a position to exert a very profound influence but
decisions are not founded on any broad discussions followed by
satisfactory consensus.

The findings of industrial occupational surveys generally help
to clarify training needs of present and future employees. The
clarification of training needs in turn influences curriculum content
and relative emphasis in employment-oriented education programs.
Industrial occupational surveys take many forms and may be classified
by their objectives. Status and trend studies\(^1\) of utilization of
selected manpower groups relate to the pattern of occupations and
skills as it exists at a point of time chosen as the basis for
future comparison. Some of these studies relate specifically to
either job descriptions or intellectual and practical skills required
for industrial occupations. The most commonly used instrument in the
latter type of industrial occupational survey is a rating scale
administered as mailed questionnaires and/or interview schedules. In
using the rating scales, respondents are usually required to rate one
of the following kinds of items:

\(^1\)See Fulmer, John L. and Green, Robert E., Summary Report from
Analysis of Georgia's Technical, Skilled and Clerical Labor Requirements
and Training Needs 1962 to 1967. Georgia Department of Labor, Atlanta,
Georgia, 1963. p.2; Hodges, T. Mansel and Boyce, T., Occupational
Survey of Manufacturing Industries in Wales: First Report - Metal
Manufacture. Welsh College of Advanced Technology, Cardiff, Wales,
October 1963. p.5; Nigeria, National Manpower Board, Nigeria's High-
(i) work activities,

(ii) items in a particular curriculum,

and (iii) levels of educational and occupational achievements.

Reports of studies relating to job descriptions or intellectual and practical skills required for industrial occupations are fairly common. Other survey methods such as Documentary Analysis and Flanagan's Critical Incident Technique have been less used in industrial occupational surveys.

If technical education is to be improved in a systematic fashion, it is essential that the attempts to define curriculum content and relative emphasis be as sophisticated as possible. A procedure which has been used sporadically in curriculum planning is Stephenson's Q-technique which facilitates the assignment of

---


priorities to curriculum objectives and subject matter content.¹

Specific Problem Considerations

The specific problem of this study is to seek answers to the following two questions:

(i) "Does controlled opinion feedback cause changes in the perception of relative curriculum emphasis?"

(ii) "Does controlled opinion feedback cause different changes in perceptions of curriculum emphasis for different levels of the same educational program?"

An investigation of the specific problem is particularly significant in that it has many implications for a wide range of practical

curriculum planning and evaluation problems including how to use more effectively:

(i) the work or professional experience of graduates or a particular educational program to improve a complete and integrated group of courses that constitute the educational program;

(ii) the expectations held by professional groups, employers, laymen and parents for a particular educational program;

and (iii) the varied expertise, work or professional experience and teaching experience of the teaching staff.
CHAPTER II

RATIONALE

Summary of Theoretical Framework

A person, in choosing what he conceives to be an effective curriculum emphasis, uses a complex set of criteria not only because perceptions of curriculum emphasis are complex but also because no one really knows clearly what constitutes an effective curriculum. The theory most directly related to the study problem is directive-state theory. The basic notion of this theory is that central directive states such as values, emotions, attitudes, interests and motivations, influence behavior generally, and perceptions in particular. Perception is usually considered an immediate act of awareness of environmental objects plus some apprehension of the "meaning" of the objects.

An implication of the central directive-state theory is that changes in perceptions may involve changes in certain aspects of some central directive states. Highly central states are very ego-involving. The term centrality implies that the change of a state high in this characteristic will change many other states, but the change of a peripheral belief may have an unimportant effect on the organization of the cognitive system. Clearly, central states are more difficult to change than peripheral or uninvolving states.

11

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
There are various phases of the processes of changing states on the central-peripheral dimension of importance. In discussing "Yielding - The Problems of Conformity" Triandis¹ says:

"Kelman distinguishes compliance from identification and internalization. Compliance occurs when an individual accepts influence because he hopes to achieve a favorable reaction from another person or group. He adopts the induced behavior not because he believes in its content but because he expects to gain specific rewards and avoid specific punishments. Identification occurs when an individual accepts influence because he wants to establish or maintain a satisfying relationship between himself and another person, or group. Identification provides satisfaction through the very act of conforming, not through rewards or punishments. Internalization can be said to occur when an individual accepts influence because the content of the induced behavior is intrinsically rewarding. The behavior is congruent with his value system or increases his understanding of the world. The content of the new behavior is the individual's source of satisfaction.

Three basic influences cause an audience to yield to a message: (a) the perceived power of the source, that is, the perceived reward-punishment effects of yielding, (b) the attractiveness of the source, and (c) the extent to which the influence fits with the existing values and cognitions of the audience. It follows from these distinctions that three characteristics of the source of message will maximize different kinds of dependent variables. Specifically, the power of the source would be most likely to lead to compliance; its attractiveness would be most likely to lead to identification, and its credibility would be most likely to lead to internalization."

There are various phases of the processes of changing states on the central-peripheral dimension of importance. In discussing "Yielding - The Problems of Conformity" Triandis¹ says:

"Kelman distinguishes compliance from identification and internalization. Compliance occurs when an individual accepts influence because he hopes to achieve a favorable reaction from another person or group. He adopts the induced behavior not because he believes in its content but because he expects to gain specific rewards and avoid specific punishments. Identification occurs when an individual accepts influence because he wants to establish or maintain a satisfying relationship between himself and another person, or group. Identification provides satisfaction through the very act of conforming, not through rewards or punishments. Internalization can be said to occur when an individual accepts influence because the content of the induced behavior is intrinsically rewarding. The behavior is congruent with his value system or increases his understanding of the world. The content of the new behavior is the individual's source of satisfaction.

Three basic influences cause an audience to yield to a message: (a) the perceived power of the source, that is, the perceived reward-punishment effects of yielding, (b) the attractiveness of the source, and (c) the extent to which the influence fits with the existing values and cognitions of the audience. It follows from these distinctions that three characteristics of the source of message will maximize different kinds of dependent variables. Specifically, the power of the source would be most likely to lead to compliance; its attractiveness would be most likely to lead to identification, and its credibility would be most likely to lead to internalization."

Review of Pertinent Research

Q technique and complex preferences

Some research problems lend themselves nicely to Q. Complex aesthetic judgments and preferences are examples. Getzels and Csikszentmihalyi\(^1\) made a creative and original use of Q procedure to study the complex and highly elusive problem of aesthetic judgment. In the study, the items used for Q sorting were 31 drawings produced under controlled conditions by a group of art students all with high artistic competence but varied degrees or orientations of artistic talent. The experimental participants consisting of two groups of experts (artists) and non-experts (graduate students) judged the drawings on three aspects of craftsmanship, originality, and aesthetic value by undertaking Q sorts of the drawings three times. Correlation coefficients were calculated for each pair of Q sorts. It was concluded in the main, that, artists differed as much among themselves in judgments of the drawings as laymen, but that they evidently related originality more to overall value than did laymen.

Sheldon and Sorenson\(^1\) observed that Q techniques permit appraisal of the beliefs, attitudes, values and self-concepts of individual students in a way not provided for by psychological tests and inventories, and consequently it offers educators a means of solving problems of measurement which could not heretofore be dealt with. Four studies were reported. The second study used Q sorts to test the hypothesis that perception of the public school curriculum is in part a function of professional educational role - as between administrators and teachers. That administrators would show a preference for a "subject centered" curriculum, and teachers would show a preference for a "student-centered" curriculum. An intercorrelation matrix was calculated and it was concluded that the hypothesis was supported.

Schill\(^2\) reported a study undertaken to determine the mathematical concepts or skills used by electronics technicians in California industries for the purpose of planning Junior College curricula. The study also sought to determine whether or not there was significant agreement among the technicians as to the rank order of mathematics from the essential to that of questionable value. The study made use of Kendall's coefficient of concordance to


measure the extent of agreement of individuals in rank-ordering items, after making a correction for tied ranks. It was reported that all of the technicians in the sample agreed, and that the agreement would have occurred by chance only one percent of the time. It was also reported that the ordering of mathematics by technicians agreed with that by instructors in the area of mathematics at the 0.01 level.

Schill\(^1\) also expressed the view that:

"The Q technique is applicable to such areas of curriculum development as the following:

a. Faculty opinion concerning the relative value of courses offered in a given curriculum.

b. Lay committee evaluation of existing curriculum content. Here it is possible to compare the lay person's opinion of what the curriculum should include with what the curriculum actually does include.

c. The content of any set of Q sort items can be arrived at by the participation of the persons who will ultimately respond to the Q sort.

d. The Q technique allows for comparison not only between individuals in terms of their opinion concerning curriculum content, but also allows for a before-and-after comparison of any given individual's opinion concerning curriculum construction due to workshops or other faculty training sessions."

\(^1\)loc. cit., p. 183.
Opinion change and social influence

Kelman\(^1\) used a research design in which there were several post-tests of opinion change to study three processes of attitude change resulting from social influence. Opinion change was assessed in three different post-test situations, under conditions of surveillance and salience, non-surveillance and salience, and non-surveillance and non-salience. In the last condition, the post-test was administered "one or two weeks after the communication session, in a different place, under different auspices, and by a different experimenter." The study showed that subjects who were given the experimental treatment designed to favor compliance manifested an opinion change only under conditions of surveillance and salience, thereby suggesting that there was no change in underlying attitude.

The second group of subjects who were given the experimental treatment designed to favor identification manifested an opinion change only under conditions of salience irrespective of whether salience was coupled with surveillance or non-surveillance. Subjects who were given the internalization treatment, however, manifested opinion changes in all three post-test situations.

\(^1\)Kelman, Herbert C., "Compliance, Identification and Internalization." Journal of Conflict Resolution, II (1968), 54-56.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Rosnow studied the question of whether subjects in a laboratory opinion-change study might become aware of an experimenter's persuasive intent even in the absence of an explicit forewarning, and, if they should become aware, whether their opinions would be manifested any differently after exposure to a one-sided as opposed to a two-sided persuasive communication.

The stimuli in the experiment consisted of a pro-fraternity and an anti-fraternity communication and two two-sided messages constructed simply by combining the pro- and anti-fraternity communications. A (faculty) communicator, whose performance had been rehearsed so as to minimize the possibility of his unwittingly providing cues that would imply his endorsement of either side, read the messages aloud while subjects in the experimental groups followed along with him by reading a mimeographed copy of the message to themselves.

For the one-sided communications group, opinion change was in whatever direction was advocated by the communicator. When a communication supported the subjects' original opinions, congruent change resulted. When a communication attacked the subject's original opinions, incongruent change resulted.

For the two-sided communications group, the result was that the direction of opinion change is anti-fraternity in the four subgroups exposed to the two-sided appeals. Rosnow explained that since the

---

communicator in this study was identified to the subjects as faculty, they probably perceived him as partial to the anti-fraternity communication. Thus motivated to please the communicator, the subjects could have been more responsive to the anti-fraternity than to pro-fraternity arguments.

Finally, Rosnow\(^1\) says:

"There is the implication here, however, that even in the absence of an explicit forewarning, and despite an experimenter's having taken the usual precautions to disguise the manipulatory character of his study (such as embedding the pre-test items in a lengthy opinion survey and delaying the treatments for one week), nevertheless, subjects may become cognizant of, or develop hypotheses about, the purpose of the study. And, consistent with Rosenthal and Orne, there is the implication that subjects' opinions can be influenced by their perceptions of a communicator's intent, with the result that they may go along with whatever position they believe he advocates."

**Controlled opinion feedback and consensus formation**

In connection with consensus formation, Uhl\(^2\) has observed as follows:

"Of course, face-to-face discussion is the usual procedure for combining individual opinions. However, for some time it has been known that there are serious problems associated with this mode of communication (Kelley and Thibaut, 1954). Some of these are:

---

\(^1\)loc. cit., p. 100-101.

1. Group opinion is highly influenced by dominant individuals who usually talk the most, yet there is very little correlation between pressure of speech and knowledge.

2. Much discussion in group situations, while appearing to be problem-oriented, is irrelevant or biasing because it is usually more concerned with individual and group interests rather than problem-solving.

3. Group pressure to conform can distort individual judgment (Asch, 1958).

In order to minimize the effects of face-to-face discussion, a procedure called Delphi Technique (named after the oracle at Delphi in ancient Greece) was developed for obtaining greater consensus among experts. The objective of the Delphi Technique is to obtain a consensus of opinions without bringing individuals together in a face-to-face meeting; this is achieved by having them complete a series of questionnaires interspersed with controlled opinion feedback.

Judd\(^1\) reports the subjective judgment or experience of application study involving the use of Delphi Technique as follows:

"Does the process work in higher education? The chairman of a liberal arts college's committee charged with developing the curriculum for a new branch campus used Delphi and concluded: "I would use the Delphi method wherever I knew there would be quite a variety of attitudes in an organization, such as a faculty, and where I wanted to ascertain what kind of consensus you could achieve. I think it aided us tremendously in knowing what we were 'getting into'. We came out of this Delphi

experience with a highly innovative and experimental
type of curricular program that has been adopted by
an extremely conservative faculty."

Statement Of Objective

The influence of controlled opinion feedback involving written
communications of perceived relative priorities coupled with brief
discussions of rationale for such relative priorities is to be
assessed in so far as it affects perception of curriculum emphasis.
Measures of perceptions of curriculum emphasis are to be devised
and evaluated. As measurement of curriculum or program component
utility is a relatively obscure area in the field of education, it
is expected that the findings of this study will also contribute to
the development of techniques for the measurement of curriculum or
program utility on which so much of the progress of accountability
in education depends.

The precise objective of this study is to seek answers to the
following two questions:

(i) "Does controlled opinion feedback cause changes in
perception of relative curriculum emphasis"?

(ii) "Does controlled opinion feedback cause different
changes in perceptions of curriculum emphasis for
different levels of the same educational program"?
For the purpose of empirical testing, the hypotheses of this study are:

(i) "Changes in the perceptions of relative curriculum emphasis are a function of controlled opinion feedback."

(ii) "Changes in the perceptions of curriculum emphasis resulting from controlled opinion feedback are a function of the educational level under consideration."
CHAPTER III

PROCEDURE

General Experimental Design

Design type

One-Group 'Pretest-Posttest' Design

<table>
<thead>
<tr>
<th>Pretest</th>
<th>Treatment</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1$</td>
<td>$X$</td>
<td>$T_2$</td>
</tr>
</tbody>
</table>

adapted as;

<table>
<thead>
<tr>
<th>Pre Q Sorts</th>
<th>Treatment</th>
<th>Post Q Sorts</th>
</tr>
</thead>
<tbody>
<tr>
<td>$QS_{A1}$, $QS_{B1}$</td>
<td>$X$</td>
<td>$QS_{A2}$, $QS_{B2}$</td>
</tr>
</tbody>
</table>

Experimental steps

(i) $QS_{A1}$ was administered as a 'Pre Q Sort' to obtain the forced-choice Q sort of a sample of subject-matter components of a curriculum as appropriate for the specified educational level 'A' before exposure to the experimental treatment $X$. $QS_{B1}$ was similarly administered in respect of educational level 'B'.
(ii) The experimental participants were exposed to the treatment X.

(iii) $Q_{SA2}$ was administered as a 'Post Q Sort' to obtain the forced-choice Q sort of the sample of subject-matter components of a curriculum as appropriate for the specified educational level 'A' after exposure to the experimental treatment X. $Q_{SB2}$ was similarly administered in respect of educational level 'B'.

**Measurement steps**

(i) Measures of differential forced-choice Q sorts were computed first for $Q_{SA1}$ and $Q_{SB1}$ and then for $Q_{SA2}$ and $Q_{SB2}$. The two measures (pre Q sort and post Q sort respectively) were then compared to determine what difference, if any, the exposure to experimental treatment X has made.

(ii) Similarly, the same type of measures were computed first for $Q_{SA1}$ and $Q_{SA2}$, and then for $Q_{SB1}$ and $Q_{SB2}$. Also a comparison of the two computed measures (for educational level A and educational level B respectively) were made to determine what difference, if any, the experimental treatment X has made.

(iii) Finally, appropriate statistical tests were used to determine whether the differences are significant in order to decide whether the null hypotheses should be accepted or rejected.
Analytical scheme

(i) For each participant, the set of four computed differential measures were calculated as correlation coefficients in respect of the four pairs of Q sort responses indicated in the first two paragraphs of sub-section headed 'Measurement steps' above. For this purpose, the Pearson product moment coefficient of correlation - difference formula, calculated from raw scores in the case of equal means and equal standard deviations was used. The formula being:

\[ r = 1 - \frac{D^2}{2No^2} \]

where \( D \) represents the difference between paired raw scores for each of the fifty items. A nomograph\(^1\) was constructed to represent the linear equation. Values '\( r \)' were read off the nomograph for the various computations of the summation of \( D^2 \).

(ii) For each pair of Q sort, the \( r \) values obtained were transposed to Fisher Z values. These values were added together and a mean Z value (i.e. \( \overline{Z} \)) was determined and the transformed back to \( r \) which serves as an index of group perception\(^2\) under the conditions pertaining to the pair of Q sorts.

\(^1\)Cohen, Jacob, "An Aid in the Computation of Correlations Based on Q Sorts." Psychological Bulletin, LIV (March 1957), 138-139.

\(^2\)Morsh, Joseph E., "The Q Sort Technique As A Group Measure." Educational and Psychological Measurement, XV (1955), 393.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
(iii) In order to satisfy the assumption of normality, the $\bar{r}$ values obtained were transposed back to Fisher $Z$ values (i.e. $Z$ values) before the tests of statistical significance were undertaken for each of the two null hypotheses:

$$
\bar{Z}_{\text{pre Q sort congruence}} \quad \bar{Z}_{\text{post Q sort congruence}}
$$

and

$$
\bar{Z}_{\text{level A change}} \quad \bar{Z}_{\text{level B change}}
$$

The tests of statistical significance were undertaken by dividing the observed difference between each pair of $Z$ values by the standard error of the difference. The quotient obtained in respect of each of the two hypotheses were essentially normal deviates which were then evaluated by reference to the table of the normal curve.

Experimental Variables

**Dependent variable**

There are two different definitions of the dependent variable corresponding to the two different sets of questions and hypotheses. The first dependent variable is 'changes in perception of relative curriculum emphasis'. The second dependent variable is 'changes in perception of curriculum emphasis'.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
In the first case, 'perception of relative curriculum emphasis' is operationally defined as follows:

" 'Perception of relative curriculum emphasis' is measured by computing the correlation coefficient of the forced-choice Q sort of the same sample of subject-matter components of a curriculum as appropriate for two different specified educational levels".

It follows therefore, that:

" 'changes in perception of relative curriculum emphasis' is measured by computing the correlation coefficient of the forced-choice Q sort of the same sample of subject-matter components of a curriculum as appropriate for the same specified educational level on two separate occasions".

Independent variables

In respect of the first hypothesis, the independent variable (controlled opinion feedback) is an active variable and is experimentally defined by the description of the experimental treatment X which induces it.

For the second hypothesis, the independent variable (level of education under consideration) is also an active variable and is also experimentally defined by the description of the experimental treatment X which induces it.

Uncontrolled variables

A deliberate control of the effects of sensitization due to pretesting has not been provided for in the experimental design. Sensitization often accounts for appreciable error variance in experimental designs involving pretests and posttests. However, the provision of several items to be sorted into many categories
in forced-choice Q sort minimises the chances of strong effects of this nuisance variable. The effects of maturation are also not expected to be appreciable as no more than six weeks elapsed between the pretest on the one hand, and experimental treatment followed immediately by the posttest on the other hand.

Experimental Treatment

Controlled opinion feedback

The experimental treatment X of controlled opinion feedback was given mainly by providing each participant with two lists (feedback cards) of subject-matter items from the forced-choice Q sort done by the formal leaders of the curriculum development process. The first part of each list consisted of items assigned the 'greatest utility' by the formal leaders of the curriculum development process, while the second part consisted of items assigned the 'least utility' by the same group. The two lists were as pertains to the two Q sorts for the two different educational levels 'A' and 'B' respectively.

In addition, as the Q sorts were done in small groups (ranging in size from six to ten), very limited personal interaction was contrived in order to further stimulate internalization. This was done by informing the participants that after reading each feedback card and for a short while before the group commenced post Q sorts each participant was free to comment, raise doubts or questions briefly on the significance or otherwise of the items in the two parts of the respective feedback card.
The net effect of the controlled opinion feedback is expected to be experimental participants' opinion change, or more precisely, 'preference change' on the part of the experimental participants. The 'preference change' is expected to result more from the participants' internalization of the credible information feedback, and less from identification with an attractive source of feedback. Furthermore, compliance with a powerful source of feedback is not expected to take place as no promise of reward or threat of punishment is expressed or implied in the experimental treatment.

**Level of education under consideration**

The part experimental treatment of 'the level of education under consideration' was given by means of specific references. Specific references to 'the level of education under consideration' were contained in 'Frame of Reference Cards' which were administered to each participant prior to undertaking each Q sort.

**Population And Sample**

The assumed population consists of specialist teachers (may be termed variously as instructors, lecturers or professors in different institutions) in post-secondary institutions offering two levels of terminal occupational programs. Such institutions are variously styled as technical institutes, technical colleges, polytechnics, colleges of technology, community colleges or state colleges. When run academically on a semi-autonomous status, such
institutions provide certification for their educational programs through parent universities, external examining agencies or national statutory accrediting/awarding agencies, while academically autonomous institutions would award their own certificates, diplomas or degrees. The two levels of terminal post-secondary programs are usually described as ordinary diploma programs and higher diploma programs in the British Commonwealth countries. In North America, they are usually described as two-year (associate diploma) technology programs and four-year (degree) technology programs respectively.

The experimental sample consisted of a convenient intact group of thirty-one specialist teachers in a single institution that had been offering occupational programs at the first level for over ten years and was just starting to offer programs at the second level. The group of thirty-one specialist teachers consisted of four teaching specialty sub-groups of:

(i) Civil Engineering Technology
(ii) Electrical Engineering Technology
(iii) Mechanical Engineering Technology
and (iv) Related Sciences.

The specialist teachers in the sample had three types of academic/professional qualifications. The first type of occupational qualification was of a more practical nature at master craftsman level. This is best described in the parlance of British Commonwealth countries as the "City and Guilds of London
Institute Full Technological Certificate". The second type of qualification was the Higher National Diploma or its equivalents as awarded by colleges in British Commonwealth countries. Finally, the third type of qualification was the university degree or equivalent professional qualifications usually accepted by statutory professional engineers registration bodies in various countries. The industrial work experiences of the specialist teachers were varied. The three types of professional qualifications possessed by the specialist teachers correspond roughly to the tripartite structuring of engineering personnel into the three categories of:

(i) Master Craftsmen
(ii) Higher Technicians
(iii) Professional Engineers.

Data and Instrumentation

Data collection

Apart from the minimal personal and identification data required for linking pretest and posttest responses, and for sorting the responses into the necessary categories, the main data obtained were the pretest and posttest Q sort responses of the participants. The responses indicated the relative practical utility of "Subject-Matter Items of a Generalized Curriculum Content for Civil, Electrical and Mechanical Engineering Technology Programs" when presented as 50-item Q sort statements. The Q sorting was done along
a bipolar scale of nine categories.

No more than six weeks elapsed between the pretest on the one hand and the experimental treatment followed immediately by the post-test on the other hand.

Instrumentation

The instrumentation consisted of the following:

(i) Q Sort Instructions
(ii) Frame of Reference Cards
(iii) Q Sort Statement Cards
(iv) Q Board
(v) Q Sort Raw Data Sheet
(vi) Feedback Card.

Specimens or illustrations of all six items are provided in appendices A to F.

Psychometric indices

The 50-item Q sort statements were specially devised for this research study and no psychometric indices of the adequacy of the statements have been developed. The following explanations both illustrate the steps taken to ensure that the indices will be adequately high as well as indicate how the indices may be developed in subsequent studies.
Neff and Helfand have suggested three procedures for establishing at least an initial indication of basic validity in research studies employing Q procedures. Firstly, the suggestion is that having a panel of experts screen the items for clarity, meaningfulness, and appropriate cell assignment (in structured Q sorts) contributes to construct validity. This procedure, however, does not settle the question of how less expert subjects will perceive the items. Secondly, in structured Q sorts which yield variance estimates at the point of replications, a test of the significance of this variance estimate will indicate the internal consistency of the replicated items attached to the various cells. This is a test of homogeneity. Thirdly, analysis of the Q sort distributions produced by persons of known characteristics contributes to the assessment of the assessment of empirical validity.

In this study, the entire group of thirty-one participants which include various subject-matter specialists screened the 50-item Q sort statements for clarity and meaningfulness before the pre Q sort. When the participants were asked to apply a three-point rating scale to the 50 items, a few questions raised and suggestions offered in relation to clarity and meaningfulness were taken into account in rephrasing the final version of the 50-item list.
Reliability is even more complicated than validity because Q procedures are concerned with ipsative considerations rather than normative considerations. Also, in applying the test-retest procedure in order to examine the reliability of a Q sort, for example, the researcher must remember that one of the postulates in Q procedure is that the individual is dynamic and changing. Thus, if successive administrations of a Q sort yield different distributions, the researcher does not know whether to conclude that the instrument is unreliable, or that the subject has shifted his beliefs, or that, the subject did not understand the instructions.¹

Furthermore, variability is an essential quality in Q sort items². Therefore, variability which would be judged as an indication of unreliability in standard normative procedures may be an excellent indication of sensitivity and discrimination power in Q procedures. In general, however, Stephenson recommends that Q sort distributions produced by a single subject on successive occasions under identical conditions should correlate at a minimum

¹Ibid.

of 0.80 for the sake of reliability\textsuperscript{1}. In other words, while the individual is dynamic and changing there is, nevertheless, continuity across time. Stephenson's recommendation does not, however, offer an easy "rule of thumb" solution to the reliability problem since he applies this to Q sort distributions produced with only a few hours intervening\textsuperscript{2}.

However, Mowrer notes also that reliability is a function of "length of test" in Q sort instruments just as in other kinds of measuring instruments\textsuperscript{3}. This means that the use of a very large number of items in the Q sort, along with a large number of discrimination categories along the preference continuum, will tend to insure maximal reliability. The tolerance of the subjects for the test must also be taken into account and test tolerance is

\begin{enumerate}
\item loc. cit., p.282.
\end{enumerate}
promoted by shorter tests. On this same issue Kerlinger says:

"The number of cards in a Q distribution is determined by convenience and statistical demands. For statistical stability and reliability, the number should probably be not less than 60 (40 or 50 in some cases) nor more than 140, in most cases no more than 100. A good range is 60 to 90 cards".

In conclusion then, reliability of Q sorts is thus an open question. Rather than use broad generalizations concerning the reliability of Q sorts, each individual Q sort must be studied in terms of carefulness of construction and appropriateness of application.

---

CHAPTER IV

CONCLUSIONS

Analytical Results

First hypothesis

TABLE 1

MEASURES OF PERCEPTION CONGRUENCE

<table>
<thead>
<tr>
<th>Participants Identification Number</th>
<th>Indices of Perception Congruence</th>
<th>Transform of Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$r_{\text{pre Q sort}}$</td>
<td>$r_{\text{post Q sort}}$</td>
</tr>
<tr>
<td>Related Sciences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>.84</td>
<td>.74</td>
</tr>
<tr>
<td>02</td>
<td>.62</td>
<td>.71</td>
</tr>
<tr>
<td>03</td>
<td>-.05</td>
<td>.05</td>
</tr>
<tr>
<td>04</td>
<td>.60</td>
<td>.00</td>
</tr>
<tr>
<td>05</td>
<td>.37</td>
<td>.52</td>
</tr>
<tr>
<td>06</td>
<td>.12</td>
<td>.15</td>
</tr>
</tbody>
</table>

36

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
<table>
<thead>
<tr>
<th>Participants Identification Number</th>
<th>Indices of Perception Congruence</th>
<th>Transform of Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$r_{\text{pre Q sort}}$</td>
<td>$r_{\text{post Q sort}}$</td>
</tr>
<tr>
<td>Civil Engineering Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>.49</td>
<td>.58</td>
</tr>
<tr>
<td>08</td>
<td>-.30</td>
<td>.00</td>
</tr>
<tr>
<td>09</td>
<td>.62</td>
<td>.52</td>
</tr>
<tr>
<td>10</td>
<td>.53</td>
<td>.56</td>
</tr>
<tr>
<td>11</td>
<td>.60</td>
<td>.62</td>
</tr>
<tr>
<td>12</td>
<td>.38</td>
<td>.62</td>
</tr>
<tr>
<td>13</td>
<td>.67</td>
<td>.21</td>
</tr>
<tr>
<td>14</td>
<td>.39</td>
<td>.63</td>
</tr>
<tr>
<td>Electrical Engineering Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>-.22</td>
<td>.61</td>
</tr>
<tr>
<td>16</td>
<td>.22</td>
<td>.21</td>
</tr>
<tr>
<td>17</td>
<td>.64</td>
<td>.42</td>
</tr>
<tr>
<td>18</td>
<td>.27</td>
<td>.32</td>
</tr>
<tr>
<td>19</td>
<td>.18</td>
<td>.31</td>
</tr>
<tr>
<td>20</td>
<td>.69</td>
<td>.49</td>
</tr>
<tr>
<td>21</td>
<td>.36</td>
<td>.30</td>
</tr>
<tr>
<td>Participants Identification Number</td>
<td>Indices of Perception Congruence</td>
<td>Transform of Indices</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>----------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td>$r_{\text{pre Q sort}}$</td>
<td>$r_{\text{post Q sort}}$</td>
</tr>
<tr>
<td>Mechanical Engineering Technology</td>
<td>.58</td>
<td>.19</td>
</tr>
<tr>
<td>22</td>
<td>.52</td>
<td>.19</td>
</tr>
<tr>
<td>23</td>
<td>.53</td>
<td>.58</td>
</tr>
<tr>
<td>24</td>
<td>.37</td>
<td>.50</td>
</tr>
<tr>
<td>25</td>
<td>-.08</td>
<td>.14</td>
</tr>
<tr>
<td>26</td>
<td>.69</td>
<td>.53</td>
</tr>
<tr>
<td>27</td>
<td>.67</td>
<td>.74</td>
</tr>
<tr>
<td>28</td>
<td>-.04</td>
<td>.17</td>
</tr>
<tr>
<td>29</td>
<td>.24</td>
<td>.40</td>
</tr>
<tr>
<td>30</td>
<td>.02</td>
<td>.45</td>
</tr>
<tr>
<td>$\bar{r}$</td>
<td>0.47</td>
<td>$\bar{r}$</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Standard error of the difference between two independent values of \( \bar{Z} \)

\[
= \sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}}
\]

\[
= 0.268 \quad \text{(as } n_1 = n_2 = 31)\]

Normal deviate = \( \frac{\text{Observed difference between the } \bar{Z} \text{ values}}{\text{Standard error of the difference}} \)

\[
= 0.071
\]

From the table of the normal curve, corresponding \( p = 0.94 \) (two-tailed).

This means that the probability of obtaining an absolute value of normal deviate equal to or greater than 0.071 is about 0.94 when the first null hypothesis

\[
\bar{r}_{\text{pre Q sort congruence}} \quad \bar{r}_{\text{post Q sort congruence}}
\]

is true. Thus, the first null hypothesis is regarded as tenable, and the conclusion is that the two observed values of \( \bar{Z} \) do not differ significantly and, therefore, the two observed values of the correlation coefficient do not differ significantly.
Second hypothesis

TABLE 2

MEASURES OF PERCEPTION CHANGE

<table>
<thead>
<tr>
<th>Participants Identification Number</th>
<th>Indices of Perception Change</th>
<th>Transforms of Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$r_{\text{level}_A}$</td>
<td>$r_{\text{level}_B}$</td>
</tr>
<tr>
<td>Related Sciences</td>
<td>01</td>
<td>.79</td>
</tr>
<tr>
<td></td>
<td>02</td>
<td>.62</td>
</tr>
<tr>
<td></td>
<td>03</td>
<td>-.09</td>
</tr>
<tr>
<td></td>
<td>04</td>
<td>.34</td>
</tr>
<tr>
<td></td>
<td>05</td>
<td>.58</td>
</tr>
<tr>
<td></td>
<td>06</td>
<td>.78</td>
</tr>
<tr>
<td>Civil Engineering Technology</td>
<td>07</td>
<td>.82</td>
</tr>
<tr>
<td></td>
<td>08</td>
<td>.69</td>
</tr>
<tr>
<td></td>
<td>09</td>
<td>-.64</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>.76</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>.74</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>.66</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>.28</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>.38</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
### TABLE 2 - continued

**MEASURES OF PERCEPTION CHANGE**

<table>
<thead>
<tr>
<th>Participants Identification Number</th>
<th>Indices of Perception Change</th>
<th>Transforms of Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\xi_{level_A}$</td>
<td>$\xi_{level_B}$</td>
</tr>
<tr>
<td><strong>Electrical Engineering Technology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>.39</td>
<td>.57</td>
</tr>
<tr>
<td>16</td>
<td>.81</td>
<td>.60</td>
</tr>
<tr>
<td>17</td>
<td>.59</td>
<td>.49</td>
</tr>
<tr>
<td>18</td>
<td>.24</td>
<td>.64</td>
</tr>
<tr>
<td>19</td>
<td>.31</td>
<td>-.12</td>
</tr>
<tr>
<td>20</td>
<td>.71</td>
<td>.62</td>
</tr>
<tr>
<td>21</td>
<td>.83</td>
<td>.57</td>
</tr>
<tr>
<td><strong>Mechanical Engineering Technology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>.67</td>
<td>.42</td>
</tr>
<tr>
<td>23</td>
<td>.40</td>
<td>.19</td>
</tr>
<tr>
<td>24</td>
<td>.14</td>
<td>.43</td>
</tr>
<tr>
<td>25</td>
<td>.45</td>
<td>.36</td>
</tr>
<tr>
<td>26</td>
<td>.28</td>
<td>-.12</td>
</tr>
<tr>
<td>27</td>
<td>.81</td>
<td>.43</td>
</tr>
<tr>
<td>28</td>
<td>.80</td>
<td>.65</td>
</tr>
<tr>
<td>29</td>
<td>.27</td>
<td>.28</td>
</tr>
<tr>
<td>30</td>
<td>.06</td>
<td>.10</td>
</tr>
<tr>
<td>31</td>
<td>.64</td>
<td>.29</td>
</tr>
<tr>
<td>$\bar{\xi}$</td>
<td>0.41</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Standard error of the difference between the two independent values of $\overline{Z}$

$$
= \sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}}
$$

= 0.268 \quad \text{(as $n_1 = n_2 = 31$)}

Normal deviate

$$
= \frac{\text{Observed difference between the $\overline{Z}$ values}}{\text{Standard error of the difference}}
$$

= 0.138

From the table of the normal curve, corresponding $p = 0.88$ (two-tailed)

This means that the probability of obtaining an absolute value of normal deviate equal to or greater than 0.138 is about 0.88 when the second null hypothesis

$$
\overline{Z}_{\text{level}_A} = \overline{Z}_{\text{level}_B}
$$

is true. Thus the second null hypothesis is regarded as tenable, and the condition is that the two observed values of $\overline{Z}$ do not differ significantly and, therefore, the two observed values of the correlation coefficient do not differ significantly.

General Findings

In general terms, for the group studied, the findings in respect of the second question is that:
"Changes in perception of curriculum emphasis took place as a result of controlled opinion feedback, but that the changes were not affected by the level of education under consideration".

Having regard to the general findings in respect of the second question about the changes in perception that took place, the findings in respect of the first question is that:

"Changes in perception of relative curriculum emphasis did not take place as a result of controlled opinion feedback".

In other words, the same pattern of perceived differences between curriculum emphases for the two levels of education is persisted in spite of the experimental treatment of controlled opinion feedback.

Wittenborn\(^1\) has discussed the issue of limited applicability of Q sort findings. Since Q sorts provide ipsative measures, it is not possible to generalize from Q sort findings to the population in general. Rather, with Q sort, one tests theories on small sets of individuals carefully selected for their 'apparent' or 'presumed' possession of some significant characteristic or characteristics. One in effect explores unknown and unfamiliar areas and variables for their identity, their inter-relations, and their functioning. It is then only possible to assume that there are probably other

---

individuals in the general population who, if they performed the Q sort under the same conditions, would be found to be similar to the experimental participants from whom the findings were gathered. There can be none of the usual rigorous generalizations as to proportionally or representativeness of specific findings in the general population.

**Recommendations For Further Study**

There is wide scope for variations in the experimental situations. This is provided by the opportunity to vary:

(i) the types of items to be used in the Q sorts - such as other kinds of curricula for different types of educational programs\(^1\) as well as for non-curricula but educational applications\(^2\);

(ii) the types of dichotomies specified in assessing perceptions of relative emphasis - such as two different options for the same level of education as is the case with electrical communications option and electrical power option in a post-secondary electrical engineering technology program;

---

\(^1\)Crawford, Aubrey A., ""Q-sort" As a Method of Determining Areas of Concern in Adult Religious Education". Religious Education. LVIII (1963), 368-369.

(iii) the sources of opinion feedback - such as current students, former students, different groups of teaching staff by professional speciality, as well as the larger society (outside the educational institutions) consisting of various groups of professional persons, employers, parents and laymen;

(iv) the types of experimental participants - such as indicated earlier in respect of sources of opinion feedback.

There is also wide scope for varying the analytical approaches. One approach is illustrated by Kerlinger1 as follows:

"Note, too, that the Q sorts of new subjects can be correlated with the arrays, a valuable procedure that has rarely been used. The correlations can be used to identify the factor predispositions of students, teachers in training and in service, administrators, and so on. This kind of use can be particularly valuable in studies of attitude, value, belief, and perception (or judgement) change. The perceptions or judgements of desirable teacher characteristics and behaviors before and after, say, special training can be correlated with ideal perceptions of the trainers, as indicated earlier, or with the factor arrays".

Another approach also illustrated by Kerlinger\textsuperscript{1} is as follows:

"In addition, Q can be used to test the effects of independent variables on complex dependent variables. One difficulty in studying attitude change under the impact of communication, interaction, and other change agents is that the effects are not simple. Ordinarily the attitude means of an experimental group is expected to increase or decrease under the impact of the independent variable or variables. With Q we can rather sensitively assess such changes of individuals by using analysis of variance and factor analysis of the data of structured Q sorts. Although they have hardly been used, such methods hold great promise for experimental studies".

Apart from applications in pilot experimental studies, Q sort explorations of perceptions of curriculum emphasis can furnish illuminating results to curriculum planners. An example in respect of the "Generalized Curriculum Content for Civil, Electrical and Mechanical Engineering Technology Programs" is the "Supplementary List of High Priority Items Identified" shown in Appendix G. With careful and enlightened interpretation this is an invaluable guide in structuring curriculum development for at least the institution where this study was conducted.

To illustrate further, some of the possible uses of Q sort technique in curriculum planning, additional sets of subject-matter items were prepared as Q sort statements and Q sorted in accordance with the dichotomies indicated in the following schedule:

\textsuperscript{1}loc. cit., p.594.
## ILLUSTRATIVE EXAMPLES OF THE APPLICATION OF Q SORTS TO CURRICULUM DEVELOPMENT

<table>
<thead>
<tr>
<th>Curriculum/Courses</th>
<th>Q Sorting Dichotomies</th>
<th>Appendix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Related Sciences Courses</td>
<td>Ordinary Level</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Diploma Level</td>
<td></td>
</tr>
<tr>
<td>Construction Technology</td>
<td>Option A - Civil</td>
<td>I</td>
</tr>
<tr>
<td>Higher Diploma (Four-Year)</td>
<td>Engineering Building</td>
<td></td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>Option A - Communications</td>
<td>J</td>
</tr>
<tr>
<td>Higher Diploma (Four-Year)</td>
<td>Power</td>
<td></td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>Option A - Production</td>
<td>K</td>
</tr>
<tr>
<td>Higher Diploma (Four-Year)</td>
<td>Option B - Maintenance</td>
<td></td>
</tr>
<tr>
<td>Curriculum</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
BIBLIOGRAPHY


Cohen, Jacob, "An Aid in the Computation of Correlations Based on Q Sorts." Psychological Bulletin, LIV (March 1957), 138-139.


APPENDIX A

Q SORT INSTRUCTIONS
Q SORT INSTRUCTIONS

General Instructions

The Q sample for this study consists of 50 statements each of which is placed on a 3" x 4" card, and is to be used by the Q sorter like a deck of playing cards. The Q sort statements constitute a sample of curriculum content items common to Ordinary Diploma or Higher Diploma instructional programs in Civil, Electrical and Mechanical Engineering Technologies.

You are asked to use the statements to represent overall judgement or opinion about the practical utility of the curriculum content items in the instruction of all students toward the educational goals of both personal development and occupational preparation in the areas of Civil, Electrical and Mechanical Engineering Technologies.

Method

Read through the deck of cards and place them into three general piles: One at the right for curriculum content items of greatest utility, one at the left for items of least utility, and one in the middle for those items about which you are neutral or have no opinion. There should be about the same number of cards in each pile.

Begin with the pile on the right (items of greatest utility).
Read them and choose the two items you rate highest in utility. Place them each in a plastic holder in column 9 on the Q-board with the statement at the top and facing you. You need not be concerned with the order of the cards within a single column.

Now go to the left pile and choose the two items you rate least in utility. Place these cards in column 1 in the same manner as before.

Next, return to the right pile. Choose the three of the remaining items you rate highest in utility and place each in a holder on the board in column 8.

Now go to the left pile and choose the three items you rate least in utility. Place each in a holder in column 2.

Continue in this manner, alternating from right to left as you approach the middle of the scale. When you have sorted all the cards in the right and left piles, sort the middle pile in the same fashion. The number of cards in each column from left to right should read, 2, 3, 6, 9, 10, 9, 6, 3, 2.

When you have finished, all fifty items will be directly in front of you on the board. You will be able to read all the cards without touching any of them. After re-reading the items, you may change the positions of any of the cards that you wish; however, each plastic holder must contain only one card.
APPENDIX B

FRAME OF REFERENCE CARDS
FRAME OF REFERENCE CARD

(Ordinary Diploma Level)

(a) The deck of cards below contains a sample of curriculum content items which will be considered in planning new programs of instruction in Civil, Electrical and Mechanical Engineering Technologies at the ORDINARY DIPLOMA level.

(b) Sort these items to represent your overall judgment or opinion about their practical utility in achieving the goals of both personal development and occupational preparation of students.

FRAME OF REFERENCE CARD

(Higher Diploma level)

(a) The deck of cards below contains a sample of curriculum content items which will be considered in planning new programs of instruction in Civil, Electrical and Mechanical Engineering Technologies at the HIGHER DIPLOMA level.

(b) Sort these items to represent your overall judgment or opinion about their practical utility in achieving the goals of both personal development and occupational preparation of students.
APPENDIX C

Q SORT STATEMENT CARDS
Q SORT STATEMENT CARDS

Each of the fifty curriculum content items listed below was assigned a random number (selected at random from 1 to 50). Each item with its random number was typed on to a 3" x 4" card.

Section I - Applied Mathematics

1. Deterministic Variables (Classical Mathematics):
   (i) Algebraic and Trigonometric Functions
   (ii) Matrices
   (iii) Differential and Integral Calculus

2. Probabilistic Variables:
   (i) Set Theory and Symbolic Logic
   (ii) Probability and Estimates of Probability
   (iii) Population and a Parameter
   (iv) Sample and a Statistic
   (v) Probability Distributions

3. Numerical Analysis:
   (i) Analytic Geometry
   (ii) Data Processing

4. Ordinary Differential Equations:
   (i) Solutions by Linear Transform Methods (Laplace, etc.)
   (ii) Theory of General Linear Differential Equations

5. Deterministic Distributed Parameter Systems:
   (i) Laplace's Equation
   (ii) Poisson's Equation
   (iii) Diffusion Equation
   (iv) Wave Equation
   (v) Solutions by Separations of Variables
   (vi) Numerical Methods of Solution
6. Miscellaneous:

(i) Counting, Combinatorial Analysis and Switching Circuits
(ii) Game Theory
(iii) Linear Programming

Section II - General Studies
(Including Applied Humanities, Social Sciences
And Fine Arts)

7. Impact of Technology:

(i) Technology and Society
(ii) Technology and Environment
(iii) Transfer of Technology
(iv) Technology and Change

8. Cultural Values:

(i) Ethics
(ii) Aesthetics (pleasure)

9. Resource Values:

(i) Materials
(ii) Energy
(iii) Information
(iv) Space
(v) People
(vi) Time

10. Value System Synthesis And Analysis:

(i) The Humanities Applied

Section III - Design

11. Introduction:

(i) Communications of Functional details (size, shape, and use)
of three-dimensional objects.

(ii) Role of Engineering Drawing in Industry.
12. Draughting Techniques I:
   (i) Fluency in interpreting and inter-relating engineering drawings

13. Draughting Techniques II:
   (i) Production of reasonable sketches

14. Draughting Techniques III:
   (i) Production of reasonable working drawings

15. DESIGN (A):
   The Morphology of Design -
   a sequence of stages with each stage terminated
   by a major decision milestone

16. DESIGN (B):
   The Anatomy of Design -
   a fundamental sequence of activities that
   are repeated in each stage of the Morphology.

Section IV - Engineering Materials

17. Structure of Matter:
   (i) Atomic aggregates
   (ii) Crystal Structure
   (iii) Crystal Growth
   (iv) Determination of Structure of Solids

18. Configuration (or Structural) Stability:
   (i) Elasticity, Surface tension, Dielectric polarization,
       Magnetization, Ferromagnetism

19. Statistical Stability:
   (i) Diffusion, Viscosity and Creep
   (ii) Rubber Elasticity
   (iii) Electrical and Thermal Conductivity

20. Configurational Instability:
   (i) Plasticity, Brittleness, Friction, Fatigue.
   Based on Structure:
   (i) Alloys
   (ii) Ceramics
   (iii) Polymers

Section V - Energy And Matter Processing

22. Conservation of Mass
23. Balance of Momentum
24. Balance of Moment of Momentum
25. Foundations of Quantum Mechanics
27. Entropy (defined generally)
28. Probability Models
29. Conservation of Change
30. Coulomb's Inverse Law of charge attraction
31. Einstein's Principles of Special Relativity.

Section VI - Technological Processes
   (Including Construction, Fabrication and Maintenance)

32. Working/Processing (Chemical, Electrical and Mechanical) of Engineering Materials:
   Metal, Wood, Land, Concrete, Plastics, etc.

33. Basic Material Forming:
   Casting, Powder Metallurgy, Electro-Mechanical, Chemical.
34. Material Removal:


35. Machinability:

Basic Principles and Geometry of Machines, Machining Variables and Economics, Power Absorption, Tool Materials, Tool Geometry, Mechanical and Electrical/Electronic Techniques, e.g. spark erosion and laser etching.

36. Plastic Flow:


37. Materials Joining:

Mechanical (including Plumbing), Welding - gas and electrical, Brazing and Soldering, Diffusion, Adhesive, Chemical (including Concreting and Mortar-Bonding), Electro-Mechanical.

38. Measurement:

Standards, Linear, Surface, Shape, Geometric, Hardness, Composition, Fits and Tolerances, Effects of Assembly, Inspection, Calibration, Temperature Control, Anti-Contamination.

39. Process Control:

Work Specification (including Coating, Rate-Fixing, Estimating), Work Scheduling (including Coating, Rate-Fixing, Estimating), Work Scheduling (including Network Analysis and Budgeting), Materials Supply, Quality Control and Inspection, Work Study.

Section III - Engineering Systems

40. Engineering Systems Behavior:

Functions and Performance Criteria of Systems such as: Buildings, Roads and Water Supply, Electrical Generation, Transmission and Distribution, Telecommunications, Broadcasting and Instrumentation, Refrigeration, Automotive and Industrial Plant.
41. Engineering Sub-Systems Fundamentals:
Principles, Construction/Fabrication and Characteristics of Sub-Systems such as: Foundations, Columns, Beams and Flow Channels, Electrical Motors, Transmission Lines and Transformers, Microwave Links, Transmitters and Sensors Compressors, Diesel Engines and Boilers.

42. Interlinking of Engineering Sub-Systems
Operating Considerations (including interphase or matching problems).

43. Engineering Sub-Systems Design and Development

44. Composite Engineering System Design and Development

Section VIII - Supervision

45. Effective Communications:
Talking, Listening, Learning, Reading, Writing.

46. Human Relations:
Theory X: The Traditional View of Direction and Control
Theory Y: The Integration of Individual and Organizational Goals
Situational Applications

47. Goal and Objective Clarification:
Unit Target Setting
Individual Target Setting
Target Categories

48. Performance Appraisal:
Unit Appraisal
Individual Appraisal
Subordinate to Supervisor Feedback

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
49. Industrial Relations:
   Labor Issues and Practices
   Labor Legislation and Industrial Strife

50. Commercial Matters:
   Sales and Service
   Purchasing, Supplies and Stores
APPENDIX D

Q BOARD
Q BOARD
With transparent plastic holders

No. of Cards
Per Column:

2 3 6 9 10 9 6 3 2

FIGURE 2. Q BOARD

Col.1 Col.2 Col.3 Col.4 Col.5 Col.6 Col.7 Col.8 Col.9
Least Greatest
Utility Utility

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Q SORT RAW DATA SHEET

<table>
<thead>
<tr>
<th>Col.1</th>
<th>Col.2</th>
<th>Col.3</th>
<th>Col.4</th>
<th>Col.5</th>
<th>Col.6</th>
<th>Col.7</th>
<th>Col.8</th>
<th>Col.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least</td>
<td>Utility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greatest</td>
<td>Utility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Generalized Curriculum Content

Ordinary Diploma/Higher Diploma*

1st Sort/2nd Sort*

Sorter's Name ................. Department ..................

Time Started .................... Time Completed ............

*Delete one item in each case as appropriate.
FEEDBACK CARD  
(Ordinary Diploma)  

The Heads of Departments have in Q Sorting the 'Generalized Curriculum Content' items indicated that the GREATEST UTILITY should be attached to the following eleven items:

(1) Item 7 - Engineering Sub-Systems Fundamentals
(2) Item 42 - Draughting Techniques I
(3) Item 8 - Draughting Techniques II
(4) Item 32 - Measurement (Workshop)
(5) Item 33 - Deterministic Variables (Classical Mathematics)
(6) Item 37 - Engineering Systems Behavior
(7) Item 44 - Materials Joining
(8) Item 15 - Working/Processing of Materials
(9) Item 31 - Classification of Engineering Materials Based on Structure
(10) Item 27 - Resource Values

The Heads of Departments have in Q sorting the 'Generalized Curriculum Content' items indicated that the LEAST UTILITY should be attached to the following eleven items:

(1) Item 38 - Foundations of Quantum Mechanics
(2) Item 43 - Einstein's Principles of Special Relativity
(3) Item 26 - Miscellaneous (Applied Mathematics)
Please study the two lists of items carefully before re-sorting the curriculum content items provided on the 'Generalized Curriculum Content' deck of cards.

FEEDBACK CARD

(Higher Diploma)

The Heads of Departments have in Q sorting the 'Generalized Curriculum Content' items indicated that the GREATEST UTILITY should be attached to the following eleven items:

(1) Item 37 - Engineering Systems Behavior

(2) Item 7 - Engineering Sub-Systems Fundamentals

(3) Item 32 - Measurement (Workshop)

(4) Item 42 - Draughting Techniques I
The Heads of Departments have in Q sorting the 'Generalized Curriculum Content' items indicated that the LEAST UTILITY should be attached to the following eleven items:

(1) Item 38 - Foundations of Quantum Mechanics
(2) Item 43 - Einstein's Principles of Special Relativity
(3) Item 28 - Structure of Matter
(4) Item 1 - Coulomb's Inverse Law of Charge Attraction
(5) Item 3 - Entropy (defined generally)
(6) Item 9 - Design A (The Morphology of Design)
(7) Item 26 - Miscellaneous (Applied Mathematics)
(8) Item 29 - Design B (The Anatomy of Design)
(9) Item 4 - Probability Models
(10) Item 18 - Value System Synthesis and Analysis
(11) Item 19 - Conservation of Charge

Please study the two lists of items carefully before re-sorting the curriculum content items provided on the 'Generalized Curriculum Content' deck of cards.
APPENDIX G

SUPPLEMENTARY LIST OF HIGH PRIORITY ITEMS IDENTIFIED
SUPPLEMENTARY LIST OF HIGH PRIORITY ITEMS IDENTIFIED

I - Generalized Curriculum Content
(Ordinary Diploma)

All the Heads of Departments in undertaking the Q sort of the 'Generalized Curriculum Content' items indicated uniformly that a MINIMUM OF AVERAGE UTILITY should be attached to the following items:

(1) Item 5 - Impact of Technology
(2) *Item 7 - Engineering Sub-Systems Fundamentals
(3) *Item 8 - Draughting Techniques II
(4) Item 12 - Conservation of Mass
(5) Item 14 - Ordinary Differential Equations
(6) *Item 15 - Working/Processing (Chemical, Electrical and Mechanical) of Engineering Materials
(7) Item 18 - Value System Synthesis and Analysis
(8) Item 22 - Balance of Moment of Momentum
(9) Item 24 - Material Removal
(10) *Item 27 - Resource Values
(11) *Item 31 - Classification of Engineering Materials Based on Structure
(12) *Item 32 - Measurement
(13) *Item 33 - Deterministic Variables (Classical Mathematics)
(14) *Item 34 - Draughting Techniques III
(15) Item 36 - Balance of Momentum
(16) *Item 37 - Engineering Systems Behavior
(17) Item 41 - Basic Material Forming
(18) *Item 42 - Draughting Techniques I
(19) *Item 44 - Material Joining
(20) Item 48 - Conservation of Energy

*Items indicated as having been assigned top priority - see Feedback Card (Ordinary Diploma) in Appendix F.
II - Generalized Curriculum Content
(Higher Diploma)

The Heads of Departments in undertaking the Q sort of the 'Generalized Curriculum Content' items indicated uniformly that a MINIMUM OF AVERAGE UTILITY should be attached to the following items:

1. *Item 2 - Deterministic Distributed Parameter Systems: (Partial Differential Equations)
2. *Item 5 - Impact of Technology
3. *Item 7 - Engineering Sub-Systems Fundamentals
4. *Item 17 - Design Introduction
5. *Item 30 - Process Control
6. *Item 37 - Engineering Systems Behavior
7. *Item 42 - Draughting Techniques I
8. *Item 46 - Commercial Matters

Further, the mean response of the Heads of Departments attached a MINIMUM OF AVERAGE UTILITY to the following additional items:

1. Item 8 - Draughting Techniques II
2. Item 10 - Numerical and Graphical Analysis
3. Item 12 - Conservation of Mass
4. Item 14 - Ordinary Differential Equations:
5. Item 15 - Working/Processing (Chemical, Electrical and Mechanical) of Engineering Materials
6. *Item 16 - Engineering Sub-Systems Design and Development

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
(7) Item 21 - Probabilistic Variables
(8) Item 24 - Material Removal
(9) Item 25 - Performance Appraisal
(10) *Item 31 - Classification of Engineering Materials
(11) *Item 32 - Measurement
(12) Item 33 - Deterministic Variables (Classical Mathematics)
(13) Item 40 - Interlinking of Engineering Sub-Systems
(14) Item 44 - Materials Joining
(15) Item 45 - Configuration (or Structural) Stability
(16) Item 47 - Cultural Values
(17) Item 50 - Configurational Instability

*Items indicated as having been assigned top priority (on the basis of mean response) - see Feedback Card (Higher Diploma) in Appendix F.

III. Structure of Priority Curriculum Content Items*
Suggested by Heads of Departments from a 50-Item Sample Generalized Curriculum Content for Ordinary (Two-Year) Diploma and Higher (Four-Year) Diploma in Engineering Technologies (Civil, Electrical and Mechanical)

<table>
<thead>
<tr>
<th>ORDINARY DIPLOMA</th>
<th>HIGHER DIPLOMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. APPLIED MATHEMATICS</td>
<td></td>
</tr>
<tr>
<td>1. Deterministic Variables (Classical Mathematics)</td>
<td>1. Deterministic Variables (Classical Mathematics)</td>
</tr>
<tr>
<td>2. Numerical Analysis</td>
<td>2. Ordinary Differential Equations</td>
</tr>
<tr>
<td>3. Ordinary Differential Equations</td>
<td>3. Deterministic Distributed Parameter Systems</td>
</tr>
</tbody>
</table>

*Curriculum Content Items uniformly assigned a MINIMUM OF AVERAGE UTILITY by all Heads of Departments.
II. GENERAL STUDIES

1. Impact of Technology
2. Resource Values
3. Cultural Values

III. DESIGN

1. Design Introduction
2. Draughting Techniques I
3. Draughting Techniques II
4. Draughting Techniques III

IV. ENGINEERING MATERIALS

1. Classification of Engineering Materials Based on Structure

V. ENERGY AND MATTER PROCESSING

1. Balance of Momentum
2. Balance of Moment of Momentum

VI. TECHNOLOGICAL PROCESSES

1. Working/Processing of Engineering Materials
2. Process Control
3. Measurement
4. Materials Joining
VII. ENGINEERING SYSTEMS

1. Engineering Systems Behavior
2. Engineering Sub-Systems Fundamentals
3. Interlinking of Engineering Sub-Systems
4. Composite Engineering System Design and Development

VIII. SUPERVISION

1. Performance Appraisal
2. Industrial Relations

1. Goal and Objective Clarification
2. Commercial Matters
APPENDIX H

ILLUSTRATIVE EXAMPLE - RELATED SCIENCES FOR ENGINEERING TECHNOLOGY PROGRAMS
ILLUSTRATIVE EXAMPLE - RELATED SCIENCES FOR ENGINEERING TECHNOLOGY PROGRAMS

I. 50-Item Sample Related Sciences Curriculum Content

SECTION I - Applied Mathematics

1. Algebraic Functions
2. Trigonometric Functions
3. Vectors, Matrices and Determinants
4. Differential Calculus
5. Integral Calculus
6. Ordinary Differential Equations
7. Partial Differential Equations
8. Probability and Estimates of Probability
9. Probability Distributions
10. Sample, Population and Parameter
11. Numerical Approximations
12. Numerical Solution of Equations
13. Computer Programming
14. Set Theory, Boolean Algebra
15. Switching Circuits
16. Linear Programming
17. Game Theory
SECTION II - Applied Physics

18. Linear Motion - Newton's Laws, Momentum
19. Statics - Composition, Resolution and Moments of Forces
20. Vibration - Simple Harmonic Motion, Force Oscillations, Resonance
22. Machine Principles - Efficiency, Frictional Effects
23. Rotational Motion - Angular Acceleration, Moments of Inertia
24. Gas Laws - Perfect and Real Gases
25. Kinetic Theory Related to Temperature; Partial Pressures
26. Expansion of Solids, Liquids and Gases
27. Specific Heats of Solids and Liquids
28. First and Second Laws of Thermodynamics - Reversible and Irreversible Processes
29. Heat Transfer - Conduction, Convection and Radiation
30. Light Waves, the Lens Formula and Optical Instruments
31. Electromagnetic Spectrum
32. Electrostatics - Capacitors
33. Ohm's Law and Direct Current Circuits
34. Electromagnetic Interaction - a.c. and d.c. Generator Principles
35. Alternating Current Theory - Reactance, Impedance and Resonance
36. Electronics - Rectification, Semi-conductor and Vacuum Tube Principles
SECTION III - Materials Science

37. Atomic and Molecular Structure

38. Types of Solids: Glass, Ceramics, Plastics, Rubber, Polymers

39. Crystal Structure and Growth

40. Survey of Solid Structure Determination with Emphasis on X-Rays

41. Semi-Conductors

42. Corrosion, Causes and Prevention

43. Elasticity and Plasticity: Stress and Strain, Constants. (Lattice Imperfections)

44. Strength of Materials
   Elementary Theory of Bending
   Deflection of Beams
   Torsion in a Wire

45. Friction in Solids:
   Static and Kinetic Friction Coefficients
   Laws and Modern Theory of Friction
   Lubrication

46. Friction in Liquids and Hydrostatic Forces:
   Viscosity: Measurement
   Turbulence
   Effect of Temperature
   Surface Tension

47. Thermal Behavior of Materials:
   Dulong and Petit's Law
   Change of State, Vapour Pressure
48. Magnetic Properties of Materials:
   Dia-, Para- and Ferromagnetism
   Hysteresis

49. Theories of Magnetism and Magnetic Domains:
   Curie Temperature
   Para- and Diamagnetism

50. Nuclear Behavior (Radioactivity)

II. STRUCTURE OF PRIORITY CURRICULUM CONTENT ITEMS*
   Suggested by Heads of Departments from a 50-Item Sample Related Sciences Curriculum Content for Ordinary (Two-Year) Diploma and Higher (Four-Year) Diploma in Engineering Technologies (Civil, Electrical and Mechanical)

<table>
<thead>
<tr>
<th>ORDINARY DIPLOMA</th>
<th>HIGHER DIPLOMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vectors, Matrices and Determinants</td>
<td>1. Vectors, Matrices and Determinants</td>
</tr>
<tr>
<td>2. Differential Calculus</td>
<td>2. Differential Calculus</td>
</tr>
<tr>
<td>3. Integral Calculus</td>
<td>3. Integral Calculus</td>
</tr>
<tr>
<td>4. Trigonometric Functions</td>
<td>4. Ordinary Differential Equations</td>
</tr>
<tr>
<td>5. Algebraic Functions</td>
<td>5. Partial Differential Equations</td>
</tr>
<tr>
<td>8. Linear Programming</td>
<td></td>
</tr>
</tbody>
</table>

*Curriculum Content Items uniformly assigned a MINIMUM OF AVERAGE UTILITY by all Heads of Departments.
II - APPLIED PHYSICS

1. Linear Motion - Newton's Laws
   Momentum

2. Vibrations - Simple Harmonic Motion, Forced Oscillations, Resonance

3. Work and Energy - Conservation and Transformation

4. Gas Laws - Perfect and Real Gases

5. Kinetic Theory Related to Temperature, Partial Pressures

6. Expansion of Solids, Liquids and Gases

7. Ohm's Law and D.C. Circuits

8. Alternating Current Theory - Reactance, Impedance and Resonance

III - MATERIALS SCIENCE

1. Types of Solids - Glass, Ceramics, Plastics, Rubber, Polymers

2. Corrosion, Causes and Prevention

3. Elasticity and Plasticity:
   Stress and Strain, Constants (Lattice Imperfections).

4. Strength of Materials
   Elementary Theory of Bending
   Deflection of Beams
   Torsion in a Wire

1. Vibrations - Simple Harmonic Motion, Forced Oscillations, Resonance

2. Rotational Motion - Angular Acceleration, Moments of Inertia

3. Expansion of Solids, Liquids and Gases

4. Friction in Solids: Static and Kinetic Friction Coefficients

5. Laws and Modern Theory of Friction

6. Lubrication

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
5. Friction in Liquids and Hydrostatic Forces:
   - Viscosity-Measurement
   - Turbulence
   - Effect of Temperature
   - Surface Tension

2. Friction in Liquids and Hydrostatic Forces:
   - Viscosity-Measurement
   - Turbulence
   - Effect of Temperature
   - Surface Tension
I. Higher (Four-Year) Diploma in Construction Technology (Civil Engineering Option and Building Option)

50-Item Sample Curriculum Content

SECTION I - SURVEYING

1. PLANE SURVEYING
   e.g. (i) Linear Measurements
        (ii) Measurement of Angles
             (iii) Leveling
                (iv) Traversing
                   (v) Stadia Surveying

2. AERIAL SURVEY
   e.g. (i) Principles of Photogrammetry
        (ii) Techniques of Photogrammetry
             (iii) Photo Interpretation
                (iv) Applications

3. GEODETIC SURVEYING
   e.g. (i) The Geoid
         (ii) Methods and Techniques of Geodesy
              (iii) Applications

4. CARTOGRAPHY
   e.g. (i) Scales
         (ii) Map Projections
             (iii) Techniques of Mapping

SECTION II - STRUCTURES

5. ENGINEERING MECHANICS
   e.g. (i) Statics
        (ii) Dynamics
             (iii) Properties of Sections
6. THEORY OF STRUCTURES
   e.g. (i) Flexure, Buckling, Torsion, Bending
         (ii) Determinate and Indeterminate Structures
         (iii) Space Framed Structures
         (iv) Elasticity and Plasticity.

7. DESIGN
   e.g. (i) Concrete Structures
        (ii) Timber Structures
        (iii) Steel Structures
        (iv) Building Codes

8. ENGINEERING DRAWING
   e.g. (i) Preparation
        (ii) Interpretation
        (iii) Detailing

SECTION III - SOIL MECHANICS AND FOUNDATION ENGINEERING

9. SOIL COMPOSITION AND PROPERTIES
   Engineering Properties of Soils
   e.g. (i) Physico-Chemical Index
        (ii) Strength
        (iii) Groundwater and Permeability
        (iv) Classification
        (v) Laboratory and Field Tests

10. SOIL STABILITY PROBLEMS
    e.g. (i) Lateral Pressures
          (ii) Slopes
          (iii) Embankments and Earth Dams
                (iv) Retaining Structures.

11. SUBSURFACE INVESTIGATION AND ENGINEERING GEOLOGY
    e.g. (i) Rock Formation
         (ii) Rock Classification
         (iii) Rock Mechanics
         (iv) Preliminary Studies
         (v) Sounding
         (vi) Airphoto

12. FOUNDATION DESIGN AND CONSTRUCTION
    e.g. (i) Bearing Capacity
         (ii) Shallow Foundations
             (iii) Deep Foundations
(iv) Settlement and Failures  
(v) Underpinning  
(vi) Stabilisation  
(vii) Construction Problems and Techniques  
including Drainage and Dewatering Techniques

SECTION IV - MATERIALS

13. METALS AND TIMBER

(a) Metals

  e.g. (i) Types and Manufacture  
        (ii) Properties and Uses

(b) Timber

  e.g. (i) Structure, Characteristics and Physical Properties  
        (ii) Conversion, Preparation, Strength and Grading  
        (iii) Use as Solid or Built-Up Component

14. CONCRETE

  e.g. (i) Aggregates and Cements  
        (ii) Concrete Types and Properties  
        (iii) Concrete Mix Design  
        (iv) Concrete Quality Control  
        (v) Plaster and Mortar Types and Properties

15. MISCELLANEOUS MATERIALS

  e.g. (i) Plastics  
        (ii) Glass  
        (iii) Putties and Mastics  
        (iv) Paints  
        (v) Bitumen, Tar and Asphalt

SECTION V - CONSTRUCTION TECHNOLOGY

16. CONCRETE PRACTICE

  e.g. (i) Production  
        (ii) Placing  
        (iii) Finishing

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
17. SPECIFICATIONS AND QUANTITIES
   (a) Specifications
   e.g. (i) Standards and Tests
        (ii) Quality
        (iii) Forms of Contract and Job Categories
   (b) Quantities
       (i) Methods of Measurement
       (ii) Substructure
       (iii) Superstructure
       (iv) Accessories and Fittings

18. ESTIMATING AND COSTING
   e.g. (i) Information Requirements and Sources
        (ii) Bills of Quantities
        (iii) Pricing
        (iv) Plant Utilization and Cost

19. MECHANICAL EQUIPMENTS AND PLANTS
    (i) Transport and Power
    (ii) Excavating and Piling
    (iii) Mixing and Lifting
    (iv) Roadmaking

20. SITE PROCESSES, ORGANISATION AND ADMINISTRATION
    (a) Measurement of Site Work
        e.g. (i) Interim Valuations and Variations
             (ii) Provisional Quantities and Fluctuations
    (b) Site Organisation and Administration
        e.g. (i) Project Parties, Functions and Inter-Relationship
             (ii) Preliminaries, Services and Plants
             (iii) Materials Scheduling and Processing
             (iv) Labor Requirements and Incentives
             (v) Site Records and Control.

SECTION VI - MAINTENANCE

21. MAINTENANCE PROCESSES
    e.g. (i) Routine Inspection and Testing
         (ii) Troubleshooting and Diagnosis
         (iii) Repairs, Modifications and Overhauls
22. MAINTENANCE ORGANISATION
   e.g. (i) Maintenance Scheduling
        (ii) Spare Parts Stock Control
        (iii) Maintenance Decisions

23. WORK STUDY
   e.g. (i) Procedure and Sequence
        (ii) Recording Techniques
        (iii) Time Study
        (iv) Motion Study

24. INDUSTRIAL AND SAFETY REGULATIONS
   e.g. (i) Safe Working Conditions and Procedures
        (ii) Statutory Registers, Diaries and Inspections
        (iii) Third Party Liability

SECTION VII - SUPERVISION

25. EFFECTIVE COMMUNICATIONS
   e.g. (i) Talking, Listening, Reading and Writing.

26. HUMAN RELATIONS
   e.g. (i) Theory X: The Traditional View of Direction and Control
        (ii) Theory Y: The Integration of Individual and Organizational Goals
        (iii) Situational Applications

27. GOAL AND OBJECTIVE CLARIFICATION
   e.g. (i) Unit Target Setting
        (ii) Individual Target Setting
        (iii) Target Categories

28. PERFORMANCE APPRAISAL
   e.g. (i) Unit Appraisal
        (ii) Individual Appraisal
        (iii) Subordinate to Supervisor Feedback
29. INDUSTRIAL ORIENTATION  
   e.g. (i) Structure of Industry  
   (ii) Structure of Industrial Occupations  
   (iii) Industrial Organisation, Functions and Communications  
   (iv) Labour Issues and Practices  
   (v) Labour Legislation and Industrial Strife  

30. COMMERCIAL MATTERS  
   e.g. (i) Sales and Service  
   (ii) Purchasing, Supplies and Stores  
   (iii) Contracts and Financing.  

SECTION VIII - SANITARY ENGINEERING  

31. PUBLIC HEALTH, ECOLOGY AND ENVIRONMENTAL POLLUTION  
   e.g. (i) Personal and Environmental Hygiene  
   (ii) Disinfection and Disinfestation  
   (iii) Environmental Resources and Conservation  
   (iv) Sanitary Microbiology and Chemistry  
   (v) Ecological Balance  
   (vi) Pollution Control  

32. WASTES DISPOSAL  
   (a) Solid Wastes  
   e.g. (i) Urban Wastes and Collection  
   (ii) Urban Wastes Disposal - Incineration  
   Landfill, Composting  
   (iii) Industrial Wastes.  

   (b) Liquid Wastes  
   e.g. (i) Liquid Waste Treatment  
   (ii) Sewerage Systems.  

33. DRAINAGE SYSTEMS  
   e.g. (i) Soil Erosion  
   (ii) Soil Conservation  
   (iii) Surface Runoff and Drainage Control
SECTION IX - TRANSPORTATION

34. TRANSPORTATION FUNDAMENTALS
   e.g. (i) Transportation Models - Air, Water
        and Land (Highway and Rail)
        (ii) Transportation Traffic and Environment
        (iii) Land Use and Land Traffic
        (iv) Planning and Administration

35. HIGHWAY PLANNING AND ECONOMICS
   e.g. (i) Traffic Studies and Analyses
        (ii) Location
        (iii) Economics and Finance

36. HIGHWAY DESIGN
   e.g. (i) Geometric Design
        (ii) Pavement Design
        (iii) Highway Bridges
        (iv) Highway Illumination

37. HIGHWAY CONSTRUCTION
   e.g. (i) Sequences of Operations - Subgrade, Subbase,
        Base and Finish
        (ii) Techniques of Construction
        (iii) Programming and Scheduling.

SECTION X - WATER RESOURCES

38. FLUID MECHANICS
   (a) Hydrostatics
   (b) Hydrodynamics
   e.g. (i) Bernoulli's Theorem
        (ii) Fluid Friction

39. HYDRAULICS
   e.g. (i) Steady Flow in Pipes and Channels of
        Uniform Cross-Section
        (ii) Flow of Water over Notches and Weirs
        (iii) Hydraulic Machinery - Pumps, Motors and
              Control Valves.
40. HYDROLOGY
   e.g. (i) Hydrological Cycle
        (ii) River Flow and Discharge
        (iii) Wells and Flow of Underground Water
        (iv) Hydrographic Survey

41. WATER SUPPLY
   e.g. (i) Demand Estimation
        (ii) Quality and Treatment
        (iii) Collection, Storage and Distribution.

42. IRRIGATION AND WATER CONSERVATION
    (i) Irrigation Types and Principles
    (ii) Conservation Structures
    (iii) Flood Control

SECTION XI - BUILDING TECHNIQUES

43. BUILDING FUNDAMENTALS
    e.g. (i) Building Systems
         (ii) Building Performance Requirements

44. SUBSTRUCTURE
    e.g. (i) Foundation Preparation - Excavating and Piling
         (ii) Foundation Types
         (iii) Basement Construction.

45. SUPERSTRUCTURE
    e.g. (i) Single and Multi-Storey Frames
         (ii) Walls, Floors and Roofs
         (iii) Doors, Windows and Stairs
         (iv) Internal and External Finishes

46. SERVICES
    e.g. (i) Preliminary and Temporary Services
         (ii) Electrical Installations
         (iii) Mechanical Installations - Refrigeration, Air Conditioning and Plumbing
         (iv) External Works - Roads, Sidewalks and Drainage.
SECTION XII - BUSINESS STUDIES

47. MUNICIPAL LAW AND ADMINISTRATION
   e.g. (i) Land Law
        (ii) Building Codes
        (iii) Local Government Law and Administration

48. COMMERCIAL LAW
   e.g. (i) Contract Law
        (ii) Company Law

49. ECONOMICS AND FINANCE
   e.g. (i) Supply and Demand
        (ii) Banks and Raising Finance
        (iii) Insurance

50. BOOKKEEPING
   e.g. (i) Petty Cash Book - (payments and receipts in cash) and Cheque Payments and Receipt Accounts
        (ii) Double-Entry Bookkeeping - Journal, Cash Book and Ledgers
        (iii) Balance Sheets
        (iv) Profit Ratios

II. STRUCTURE OF PRIORITY CURRICULUM CONTENT ITEMS*
Suggested by Teaching Staff Specialists (in Civil Engineering and Building respectively)
from a 50-Item Sample Curriculum Content for Higher (Four-Year) Diploma in Construction Technology (Civil Engineering Option (A) and Building Option (B))

OPTION A - CIVIL ENGINEERING

I. SURVEYING

NIL

II. STRUCTURES

1. Theory of Structures
2. Design

OPTION B - BUILDING

I. SURVEYING

NIL

II. STRUCTURES

1. Theory of Structures
2. Design
3. Engineering Mechanics

*Curriculum Content Items uniformly assigned a MINIMUM OF AVERAGE UTILITY by all Heads of Departments.
III. SOIL MECHANICS AND FOUNDATION ENGINEERING

1. Soil Stability Problems
2. Subsurface Investigation and Engineering Geology
3. Foundation Design and Construction

IV. MATERIALS

NIL

1. Concrete

V. CONSTRUCTION TECHNOLOGY

1. Specification and Quantities
2. Site Processes, Organisation and Administration
3. Mechanical Equipments and Plants

VI. MAINTENANCE

1. Public Health, Ecology and Environmental Pollution
2. Wastes Disposal
3. Drainage Systems

IX. TRANSPORTATION

1. Transportation Fundamentals
2. Highway Planning and Economics
3. Highway Design
4. Highway Construction
X. WATER RESOURCES

1. Hydraulics
2. Hydrology
3. Water Supply
4. Irrigation and Water Conservation

XI. BUILDING TECHNIQUES

1. Substructure
2. Superstructure

XII. BUSINESS STUDIES

NIL

III. STRUCTURE OF BASIC CURRICULUM OUTLINE*

Suggested by Departmental Specialist (in Civil Engineering and Building respectively)
from a 50-Item Sample Curriculum Content for
Higher (Four-Year) Diploma in Construction
(Civil Engineering Option (A) and Building Option (B))

OPTION A - CIVIL ENGINEERING

I. SURVEYING

NIL

OPTION B - BUILDING

1. Plane Surveying

*(a) Curriculum Content Items uniformly assigned a MINIMUM OF AVERAGE UTILITY in respect of Option A - Civil Engineering,
and (b) Curriculum Content Items assigned a MINIMUM OF AVERAGE UTILITY on the basis of mean response in respect of Option B - Building.
II. STRUCTURES

1. Theory of Structures
2. Design
3. Engineering

III. SOIL MECHANICS AND FOUNDATION ENGINEERING

1. Soil Stability
2. Subsurface Investigation and Engineering Geology
3. Foundation Design and Construction
4. Soil Composition and Properties

IV. MATERIALS

NIL

1. Concrete

V. CONSTRUCTION TECHNOLOGY

1. Specifications and Quantities
2. Site Processes, Organisation and Administration
3. Concrete Practice
4. Mechanical Equipments and Plants

VI. MAINTENANCE

1. Maintenance
2. Work Study

NIL

VIII. SANITARY ENGINEERING

1. Public Health, Ecology and Environmental Pollution
2. Wastes Disposal
3. Drainage Systems
IX. TRANSPORTATION

1. Transportation Fundamentals NIL
2. Highway Planning and Economics
3. Highway Design
4. Highway Construction

X. WATER RESOURCES

1. Hydraulics NIL
2. Hydrology
3. Water Supply
4. Irrigation and Water Conservation

XI. BUILDING TECHNIQUES

1. Substructure
2. Superstructure
3. Building Fundamentals
APPENDIX J

ILLUSTRATIVE EXAMPLE - ELECTRICAL ENGINEERING TECHNOLOGY
I. Higher Diploma in Electrical Engineering Technology
(Power Option and Communications Option)
50-Item Sample Curriculum Content

SECTION I - ELECTRICAL FUNDAMENTALS

1. MATERIALS AND FIELDS
   e.g. (i) Dielectric Materials, Electric Fields and Capacitance
        (ii) Ferromagnetic Materials, Magnetic Circuits and Eddy Current Losses
        (iii) Magnetic and Electric Field Plotting for Simple Geometric Systems
        (iv) Saturable Reactors and Simple Magnetic Amplifier Circuits

2. ELECTRICAL MACHINES THEORY
   e.g. (i) Rotating Magnetic Fields
        (ii) 3-phase Synchronous Motors
        (iii) 3-phase Cage-Rotor Induction Motors
        (iv) Single-phase, Split-phase, Capacitor Start and Universal Motors
        (v) D.C. Machines

3. ELECTRICAL CIRCUIT CALCULATIONS
   e.g. (i) Complex D.C. Networks
        (ii) Single Phase A.C. Circuits and Operator j
        (iii) Balanced 3-phase Circuits
        (iv) Complex A.C. Networks

4. ELECTRICAL CIRCUIT THEORY
   e.g. (i) Waveforms - Fundamental and Harmonic Components
        (ii) RL, RC and LC Two-Terminal and Four-Terminal Networks
        (iii) Mutual Inductance and Coupled Impedance
        (iv) Transient Response
        (v) Frequency Response
        (vi) Feedback

5. MEASUREMENT PRINCIPLES
   e.g. (i) Indicating Instrument Principles - Electrostatic, Electrodynamic, Induction, Thermo-couple, etc.
        (ii) Power, Frequency and Power Factor Meters
        (iii) Single-phase and 3-Phase (balanced and unbalanced) Power Measurements
        (iv) A.C. Bridges

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
6. MEASUREMENT APPLICATIONS

   e.g. (i) Applications, Limitations and Calibration of Commercial Instruments
        (ii) Fluxmeter Applications
        (iii) Commercial Type A.C. Bridges
        (iv) Valve Voltmeters and Q Meters
        (v) Cathode Ray Oscilloscopes

SECTION II - ELECTRICAL WORKSHOP TECHNOLOGY

7. MACHINE SHOP PRACTICE

   e.g. (i) Measurements
        (ii) Machine Tools
        (iii) Heat Treatment

8. SHEET METAL WORK AND MATERIALS JOINING

   e.g. (i) Bending Machines and Chassis Manufacture
        (ii) Drill Templates, Punching, Blanking and Piercing Methods
        (iii) Hard and Soft Soldering
        (iv) Welding
        (v) Mechanical Joints and Fastenings
        (vi) Adhesives, Epoxy Resins, Laminations and Chemical Etching (of Printed Circuit Boards)

9. PARTS ASSEMBLY DRAWING AND DESIGN

   e.g. (i) Fastenings
        (ii) Fits and Finishes
        (iii) Welding Drawings
        (iv) Pipe Drawings
        (v) Assembly Sectioning

10. ELECTRICAL - ELECTRONIC DRAWING

    e.g. (i) Electrical Symbols, Diagrams and Charts
         (ii) Electrical Draughting Techniques
         (iii) Typical Electrical Circuits
         (iv) Interpretation of Industrial Prints
SECTION III - BASIC ELECTRONICS

11. ELECTRON PHYSICS AND SEMICONDUCTOR THEORY
   e.g. (i) Atomic Structure
        (ii) Thermionic Emission
        (iii) Intrinsic Conduction - Hole and Electron Flow
        (iv) PN Junctions

12. ELECTRONIC DEVICES AND POWER SUPPLIES
    e.g. (i) Valve (Hard and Soft) Characteristics, Parameters
          and Frequency Response
          (ii) Transistor Configurations, Characteristics and
               Frequency Response
          (iii) Valve and Semi-Conductor Rectifiers
          (iv) Smoothing and Regulation
          (v) Controlled Rectifier Circuits
          (vi) Photo-Conductive and Photo-Voltaic cells,
               Photo-Transistor Effect

13. AUDIO FREQUENCY AMPLIFIERS
    e.g. (i) Graphical and Equivalent Circuit Analysis of
          Resistive Loaded Amplifiers
          (ii) Practical Circuit Arrangements for Resistive-
               Loaded Amplifiers
          (iii) Power Amplifiers
          (iv) High Fidelity and Public Address Systems

14. RADIO FREQUENCY CIRCUITS
    e.g. (i) Tuned Amplifiers
          (ii) Feedback and Oscillators
          (iii) Modulation, Mixing and Detector Circuits

SECTION IV - RADIO SYSTEMS

15. RADIO TRANSMITTERS, RECEIVERS AND COMMUNICATION
    SYSTEMS FUNDAMENTALS
    e.g. (i) Amplitude Modulation
          (ii) Frequency Modulation
          (iii) Pulse Code Modulation
16. BROADCAST STUDIO TECHNIQUES
   e.g. (i) Acoustics and Studio Lighting
        (ii) Broadcast Program Sources - Equipment and Standards
        (iii) Control Room - Equipment and Test Procedures
        (iv) Program Distribution Networks

17. RADIO AND LINE TRANSMISSION TECHNIQUES
   e.g. (i) Transmitting Aerials and Feeders
        (ii) Propagation
        (iii) Parallel Operation of Transmitters
        (iv) Performance Tests and Frequency Checking

18. RADIO TELEVISION AND ELECTRONIC SERVICING
   e.g. (i) General Procedure - Initial Bracketing and Narrowing Down
        (ii) Location of Check - Linear, Divergent, Convergent, Switching and Feedback Paths, Precedence Rule
        (iii) Types of Checks
        (iv) Typical Malfunctions

19. MICROWAVES
   e.g. (i) Microwave Tubes
        (ii) Waveguides and Cavity Resonators
        (iii) Transmission Lines

SECTION V - CONTROL SYSTEMS

20. CONTROL SYSTEMS FUNDAMENTALS
    e.g. (i) Control System Components
         (ii) D.C. Servomechanisms
         (iii) A.C. Servomechanisms
         (iv) Hydraulic and Pneumatic Servomechanisms

21. SYSTEM ANALOGUES AND ANALOGUE COMPUTING UNITS
    e.g. (i) Analogue Devices and Components
         (ii) Analogue to Digital Conversion
         (iii) Linear Computing Elements
         (iv) Non-Linear Computing Elements
         (v) Scale - Factor Techniques

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
SECTION VI - DIGITAL SYSTEMS

22. WAVE-SHAPING CIRCUITS
   e.g. (i) Clipping, Clamping, Integrating and Differentiating Circuits
        (ii) Logic Circuits and Registers
        (iii) Binary and Decade Counting Circuits
        (iv) Magnetic Core Binary Elements

23. PULSE SYSTEMS
   e.g. (i) Television Signal-Scanning, Synchronization and Separation
        (ii) Basic Elements of a Radar System
        (iii) Time-Base Modulation and Phase-Modulation Systems
        (iv) Pulsed Oscillators and Time Measurements

24. TELEPHONY FUNDAMENTALS
   e.g. (i) Manual Switching Arrangements
        (ii) Automatic Switching Principles
        (iii) Automatic Switching Mechanisms
        (iv) Traffic and Trunking
        (v) Cabling, Wiring and Protection

25. TELEGRAPHY FUNDAMENTALS
   e.g. (i) Telegraph Codes and Signalling
        (ii) Telegraph Transmission Theory
        (iii) Telegraph Circuits

SECTION VII - POWER GENERATION

26. ECONOMICS OF POWER SUPPLY
   e.g. (i) Standing and Running Costs
        (ii) Load, Diversity and Loss Factors
        (iii) Economics of Power Factor Correction
        (iv) Comparative Generation Costs of Power Station Siting, Types of Fuels and Systems
        (v) Cost of Supply and Two-Part Tariffs
27. GENERATOR PRINCIPLES AND CONSTRUCTION
   e.g. (i) Salient and Non-Salient Types of Rotor Construction
        (ii) Construction of Body, Windings, Insulation and Slip Ring Assembly
        (iii) Construction of Stator Body Windings and Insulation
        (iv) Cooling Systems
        (v) Effects of Armature Reaction and Stator Winding Schemes

28. GENERATOR OPERATION AND CONTROL SYSTEMS
   e.g. (i) Parallel Operation and Synchronising
        (ii) Transient Operational Considerations
        (iii) Exciters
        (iv) Automatic Voltage Regulators

SECTION VII - POWER DISTRIBUTION

29. OVERHEAD LINES AND CABLES
   e.g. (i) Line Conductor Manufacture, Connections and Arrangements
        (ii) Pole and Pole Structure Preparation and Erection
        (iii) Towers - Foundations, Erection and Earthing
        (iv) Cable Types and Arrangements
        (v) Cable Laying and Protection
        (vi) Cable Jointing and Fault Location
        (vii) Environmental Effects and Precautions

30. SWITCHGEAR AND SUBSTATIONS
    e.g. (i) Switchgear Principles and Types
         (ii) Switchgear Testing
         (iii) Substation Layouts
         (iv) Busbar Arrangements
         (v) Performance of Transmission Lines

31. TRANSFORMERS
    e.g. (i) Transformer Principles, Construction and Connections
         (ii) Equivalent Circuits, Parallel Operation and Protection
         (iii) Cooling Systems and Transformer Oil
         (iv) Phasing Out and Commissioning Procedures

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
32. DISTRIBUTION NETWORKS
   e.g. (i) Radial, Ring and Interconnected Distribution Systems
   (ii) Network Regulation and Power Loss Calculations
   (iii) Practical Arrangements - Link Boxes, Pillars and Fuses

33. PROTECTION
   e.g. (i) Protection Principles - Core, Voltage or Current Balance, etc.
   (ii) Protection Applications - Generators, Transformers, Feeders and Busbars
   (iii) Short Circuit Calculations
   (iv) Earthing

SECTION IX - POWER UTILISATION

34. CONSUMER INSTALLATIONS
   e.g. (i) Wiring Systems
   (ii) Circuit Control and Protective Devices
   (iii) Earthing
   (iv) Metering

35. AIR CONDITIONING
   e.g. (i) Energy Requirements Calculations and Equipment Selection
   (ii) Controls
   (iii) Plant Operation and Maintenance

36. REFRIGERATION
   e.g. (i) Absorption and Compression Units
   (ii) Equipment Selection for Domestic and Industrial Situations
   (iii) Controls
   (iv) Cold Storage Plant Operation and Maintenance

37. ALTERNATIVE CURRENT MACHINES
   e.g. (i) Synchronous Motors
   (ii) Asynchronous Motors
   (iii) Commutator Motors
   (iv) Operation Analysis - Circle Diagram, Equivalent Circuits and Speed Control
   (v) Starting Methods
38. MOTOR CONTROL AND PROTECTION
   e.g. (i) Protection Devices - Overload and Under-Voltage
        (ii) Starters and Remove Control
        (iii) Speed Control and Braking
        (iv) Drives and Couplings

SECTION X - UTILISATION PLANNING

39. CONSUMER DISTRIBUTION PLANNING
   e.g. (i) Switchgear, Fusegear and Circuit Arrangements
        (ii) Diversity Factor
        (iii) Cable and Switchgear Estimation
        (iv) Wiring Regulations, Codes of Practice, and Standards
        (v) Practical Lighting and Power Schemes
        (vi) Specifications Preparation
        (vii) Installation Costing and Estimation

40. ILLUMINATION
   e.g. (i) Terms, Units and Principles
        (ii) Lamps and Fittings
        (iii) Levels of Illumination and Lighting Schemes
        (iv) Specifications and Costing

SECTION XI - MAINTENANCE

41. MAINTENANCE PROCESSES
   e.g. (i) Routine Inspection and Testing
        (ii) Troubleshooting and Diagnosis
        (iii) Repairs, Modifications and Overhauls

42. MAINTENANCE ORGANISATION
   e.g. (i) Maintenance Scheduling
        (ii) Spare Parts and Stock Control
        (iii) Maintenance Decisions

43. WORK STUDY
   e.g. (i) Procedure and Sequence
        (ii) Recording Techniques
        (iii) Time Study
        (iv) Motion Study

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
44. INDUSTRIAL AND SAFETY REGULATIONS
   e.g. (i) Safe Working Conditions and Procedures
        (ii) Statutory Registers, Diaries and Inspections
        (iii) Third Party Liability

SECTION XII - SUPERVISION

45. EFFECTIVE COMMUNICATIONS
   e.g. (i) Talking, Listening, Reading and Writing

46. HUMAN RELATIONS
   e.g. (i) Theory X: The Traditional View of Direction and Control
        (ii) Theory Y: The Integration of Individual and Organisational Goals
        (iii) Situational Applications

47. GOAL AND OBJECTIVE CLARIFICATION
   e.g. (i) Unit Target Setting
        (ii) Individual Target Setting
        (iii) Target Categories

48. PERFORMANCE APPRAISAL
   e.g. (i) Unit Appraisal
        (ii) Individual Appraisal
        (iii) Subordinate to Supervisor Feedback

49. INDUSTRIAL ORIENTATION
   e.g. (i) Structure of Industry
        (ii) Structure of Industrial Occupations
        (iii) Industrial Organisation, Functions and Communications
        (iv) Labor Issues and Practices
        (v) Labor Legislation and Industrial Strife

50. COMMERCIAL MATTERS
   e.g. (i) Sales and Service
        (ii) Purchasing, Supplies and Stores
        (iii) Contracts and Financing
II. STRUCTURE OF PRIORITY CURRICULUM CONTENT ITEMS*
Suggested by Teaching Staff Specialists (in Communications and Power respectively) from a 50-Item Sample Curriculum Content for
Higher (Four-Year) Diploma in Electrical Engineering (Communications Option (A) and Power Option (B))

OPTION A - COMMUNICATIONS

I. ELECTRICAL FUNDAMENTALS

1. Electrical Circuit Theory
2. Measurement Principles
3. Measurement Applications

II. ELECTRICAL WORKSHOP TECHNOLOGY

1. Electrical/Electronic Drawing

OPTION B - POWER

I. ELECTRICAL FUNDAMENTALS

1. Electrical Machines Theory

II. BASIC ELECTRONICS

1. Electron Physics and Semiconductor Theory
2. Electronic Devices and Power Supplies
3. Audio Frequency Amplifiers

IV. RADIO SYSTEMS

1. Radio Transmitters, Receivers and Communication System Fundamentals
2. Broadcast Studio Techniques
3. Radio and Line Transmission Techniques

*Curriculum Content Items uniformly assigned a MINIMUM OF AVERAGE UTILITY by all Heads of Departments.
4. Radio, Television and Electronic Servicing

5. Microwaves

V. CONTROL SYSTEMS

1. Control Systems Fundamentals

VI. DIGITAL SYSTEMS

1. Wave-Shaping Circuits
   NIL

2. Pulse Systems

3. Telephony Fundamentals

VII. POWER GENERATION

NIL

1. Economics of Power Supply

2. Generator Principles and Construction

3. Generator Operation and Control Systems

VIII. POWER DISTRIBUTION

NIL

1. Overhead Lines and Cables

2. Switchgear and Substations

3. Transformers

4. Distribution Networks

5. Protection

IX. POWER UTILISATION

NIL

1. Consumer Installation

2. Alternating Current Machines

3. Motor Control and Protection

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
X. UTILISATION PLANNING

1. Illumination

2. Consumer Distribution Planning

XI. MAINTENANCE

NIL

1. Maintenance Processes

2. Maintenance Organisation

III. STRUCTURE OF BASIC CURRICULUM OUTLINE*

Suggested by Departmental Specialists (in Communications and Power respectively)

from a 50-Item Sample Curriculum Content

for

Higher (Four-Year) Diploma in Electrical Engineering

(Communications Option (A) and Power Option (B))

OPTION A - COMMUNICATIONS

I. ELECTRICAL FUNDAMENTALS

1. Materials and Fields

2. Electrical Circuit Calculations

3. Electrical Circuit Theory

4. Measurement Principles

5. Measurement Applications

II. ELECTRICAL WORKSHOP TECHNOLOGY

1. Electrical/Electronic Drawing

OPTION B - POWER

I. ELECTRICAL FUNDAMENTALS

1. Materials and Fields

2. Electrical Circuit Calculations

3. Electrical Machines Theory

4. Measurement Principles

*Curriculum Content Items assigned a MINIMUM OF AVERAGE UTILITY on the basis of mean response in respect of both Options.
III. BASIC ELECTRONICS

1. Electron Physics and Semiconductor Theory
2. Electronic Devices and Power Supplies
3. Audio Frequency Amplifiers
4. Radio Frequency Circuits

IV. RADIO SYSTEMS

1. Radio Transmitters, Receivers and Communication Systems Fundamentals
2. Broadcast Studio Techniques
3. Radio and Line Transmission Techniques
4. Radio, Television and Electronic Servicing
5. Microwaves

V. CONTROL SYSTEMS

1. Control Systems Fundamentals
2. System Analogues and Analogue Computing Units

VI. DIGITAL SYSTEMS

1. Wave-Shaping Circuits
2. Pulse Systems
3. Telephony Fundamentals
4. Telegraphy Fundamentals
VII. POWER GENERATION

NIL

1. Economics of Power Supply
2. Generator Principles and Construction
3. Generator Operation and Control Systems

VIII. POWER DISTRIBUTION

1. Overhead Lines and Cables
2. Switchgear and Substations
3. Transformers
3. Transformers
4. Distribution Methods
5. Protection

IX. POWER UTILISATION

NIL

1. Consumer Installations
2. Alternating Current Machines
3. Motor Control and Protection

X. UTILISATION PLANNING

1. Illumination
1. Illumination
2. Consumer Distribution Planning

XI. MAINTENANCE

1. Industrial and Safety Regulations
1. Maintenance Processes
2. Maintenance Organisation

XII. SUPERVISION

NIL

1. Effective Communications

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
APPENDIX K

ILLUSTRATIVE EXAMPLE – MECHANICAL ENGINEERING TECHNOLOGY
I. Higher Diploma in Mechanical Engineering Technology
   (Production Option and Maintenance Option)
   50-Item Sample Curriculum Content

SECTION I - DRAWING AND DESIGN

1. PARTS ASSEMBLY DRAWING AND DESIGN
   e.g. (i) Fastenings
        (ii) Fits and Finishes
        (iii) Welding Drawings
        (iv) Pipe Drawings
        (v) Assembly Sectioning

2. DRAWING AND DESIGN OF MACHINE ELEMENTS
   e.g. (i) Couplings and Clutches
        (ii) Gears and Screws
        (iii) Shafts and Bearings
        (iv) Belts, Pulleys and Flywheel
        (v) Cams and Cranks

3. JIG AND TOOL DRAWING AND DESIGN
   e.g. (i) Jigs and Fixtures
        (ii) Cutting Tools
        (iii) Turret Lathe Tools
        (iv) Punches and Dies
        (v) Gauges

4. PRODUCT DESIGN
   e.g. (i) Design Process
        (ii) Design Factors - Function, Construction and Appearance
        (iii) Limitations imposed by - Manufacturing Processes, Cost and Obsolescence

SECTION II - APPLIED MECHANICS

5. MATERIALS, STRESS AND STRAIN
   e.g. (i) Stress and Strain Measurements and Calculations
        (ii) Riveted and Welded Joints
        (iii) Pressure Vessels
        (iv) Combined Stresses
        (v) Materials Testing - Tension, Compression, Torsion, Shear, Hardness and Impact
6. BEAMS AND SHAFTS
   e.g.  (i) Centre of Gravity, Centroids and Moments of Inertia
         (ii) Beams - Shear Forces and Bending Moments
         (iii) Torsion, Shafts, Shaft Couplings and Keys
         (iv) Columns and Indeterminate Beams

7. DYNAMICS AND KINETIC ENERGY
   e.g.  (i) Rigid Body Dynamics
         (ii) Linear and Angular Displacement and Velocity
         (iii) Conservation of Energy - Flywheels
         (iv) Acceleration of Geared Systems
         (v) Balancing

8. TRIBOLOGY
   e.g.  (i) Friction
         (ii) Lubrication
         (iii) Wear

9. MECHANICAL VIBRATIONS
   e.g.  (i) Free and Forced Vibrations
         (ii) Machinery Vibration, Mounting Resonance and Damping
         (iii) Torsional Oscillations of Shafts, Transverse Vibrations of Beams and Whirling of Shafts

SECTION III - FLUID TECHNOLOGY

10. FLUID MECHANICS
    (a) Hydrostatics
    (b) Hydrodynamics
        e.g.  (i) Bernoulli's Theorem
              (ii) Fluid Friction

11. HYDRAULIC MACHINERY
    e.g.  (i) Hydraulic Pumps
          (ii) Hydraulic Motors
          (iii) Control Valves

12. PNEUMATIC MACHINERY
    e.g.  (i) Air Compressors - Principles, Construction and Utilisation
          (ii) Pneumatic Controls - Directional Control Valves, Flow Control Valves, Sequence Valves
          (iii) Air Cylinders
SECTION IV - WORKSHOP TECHNOLOGY

13. MACHINABILITY
   e.g. (i) Basic Principles and Geometry of Machines
        (ii) Machining Variables and Economics
        (iii) Power Absorption
        (iv) Tool Materials and Geometry

14. MACHINE SHOP PRACTICE
   e.g. (i) Measurements
        (ii) Machine Tools
        (iii) Numerical Control

15. MATERIAL JOINING TECHNIQUES
    e.g. (i) Arc and Oxy-Acetylene Welding
         (ii) Submerged Melt and Inert Gas Shielded Welding
         (iii) Welded Joints and Welding Economy
         (iv) Adhesives, Epoxy Resins, Laminations and Chemical Etching.

16. PLASTIC FLOW TECHNIQUES
    e.g. (i) Forging and Bending
         (ii) Stretch Forming and Deep Drawing
         (iii) Spinning and Flow Turning
         (iv) Extrusion and Wire Drawing
         (v) Cold Rolling and High Energy Forming

17. FOUNDRY PRACTICE
    e.g. (i) Pattern making and Moulding
         (ii) Coring and Casting
         (iii) Gating and Risering
         (iv) Machinery and Accessories

18. FOUNDRY PLANNING
    e.g. (i) Die Casting
         (ii) Investment Casting
         (iii) Casting Design and Economy

19. METALLURGY
    e.g. (i) Heat Treating
         (ii) Basic Inspection and Testing of Metals
         (iii) Basic Metallography
         (iv) Electro/Chemical Methods
SECTION V - INDUSTRIAL PLANNING ANALYSIS

20. COST ESTIMATING
   e.g. (i) Information Requirements and Sources
        (ii) Product Specifications
        (iii) Cost Methods
        (iv) Costing Elements
        (v) Plant Utilisation and Cost

21. PRODUCTION SCHEDULING
   e.g. (i) Scheduling
        (ii) Machine Loading and Manpower Loading
        (iii) Inventory, Scrap and Salvage
        (iv) Ordering and Stock Control

22. QUANTITATIVE ANALYSIS
   e.g. (i) Operations Research
        (ii) Linear Programming and Waiting Lines
        (iii) Economic Order Quantity
        (iv) Forecasting

SECTION VI - INDUSTRIAL OPERATIONS ANALYSIS

23. PROCESS ANALYSIS
   e.g. (i) Operation Process
        (ii) Flow Process
        (iii) Man and Machine Process
        (iv) Gang Process
        (v) Operator Process

24. RESOURCE ANALYSIS
   e.g. (i) Principles
        (ii) Resource Planning
        (iii) Resource Allocation
        (iv) Resource Smoothing
        (v) Resource Management

25. STATISTICS AND QUALITY CONTROL
   e.g. (i) Numbers and Measurements
        (ii) Probability and Frequency Distribution
        (iii) Control Charts for Variables, Defectives and Defects
        (iv) Acceptance Sampling
        (v) Input Quality and Output Quality
        (vi) Reliability and Maintainability

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
26. PRODUCTIVITY ANALYSIS  
e.g.  (i) Productivity Standards and Measurements  
     (ii) Production Indices  
     (iii) Work-flow and Inventory Performance  
     (iv) Quality and Personnel Performance

27. PROJECT PLANNING ANALYSIS  
e.g.  (i) Repetition and Reversibility  
     (ii) Sensitivity Analysis  
     (iii) Utility Transforms  
     (iv) Network Analysis

SECTION VII - SUPERVISION

28. EFFECTIVE COMMUNICATIONS  
e.g.  (i) Talking, Listening, Reading and Writing

29. HUMAN RELATIONS  
e.g.  (i) Theory X: The Traditional View of Direction and Control  
     (ii) Theory Y: The Integration of Individual and Organisational Goals  
     (iii) Situational Applications

30. GOAL AND OBJECTIVE CLARIFICATION  
e.g.  (i) Unit Target Setting  
     (ii) Individual Target Setting  
     (iii) Target Categories

31. PERFORMANCE APPRAISAL  
e.g.  (i) Unit Appraisal  
     (ii) Individual Appraisal  
     (iii) Subordinate to Supervisor Feedback

32. INDUSTRIAL ORIENTATION  
e.g.  (i) Structure of Industry  
     (ii) Structure of Industrial Occupations  
     (iii) Industrial Organisation, Functions and Communications  
     (iv) Labor Issues and Practices  
     (v) Labor Legislation and Industrial Strife
33. COMMERCIAL MATTERS
  e.g.  (i) Sales and Service
        (ii) Purchasing, Supplies and Stores
        (iii) Contracts and Financing

SECTION VIII - WORKS SERVICES

34. PLANT PLANNING
  e.g.  (i) Plant Layout
        (ii) Plant Handling
        (iii) Plant Installation
        (iv) Material Handling

35. PLANT OPERATIONS
  e.g.  (i) Boiler House Practice
        (ii) Utility Distribution and Practice - Steam and
            Hot Water, Compressed Air, Water and Electricity

SECTION IX - HEAT ENGINE SYSTEMS

36. BASIC THERMODYNAMICS
  e.g.  (i) Basic Theory
        (ii) Fuels and Combustion

37. APPLIED THERMODYNAMICS
  e.g.  (i) Steam Plant
        (ii) Gas Plant

38. AIR CONDITIONING
  e.g.  (i) Energy Requirements Calculations and Equipment
        Selection
        (ii) Controls
        (iii) Plant Operation and Maintenance

39. REFRIGERATION
  e.g.  (i) Absorption and Compression Units
        (ii) Equipment Selection for Domestic and Industrial
             Situations
        (iii) Controls
        (iv) Cold Storage Plant Operation and Maintenance

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
40. AUTOMOTIVE ENGINES AND PRIME MOVERS
   e.g. (i) Engine Construction and Operation
        (ii) Cooling and Fuel Systems
        (iii) Ignition and Electrical Systems

41. AUTOMOTIVE ENGINES
    e.g. (i) Chassis
         (ii) Transmission and Drive Systems
         (iii) Testing

SECTION X - MAINTENANCE

42. MAINTENANCE PROCESSES
    e.g. (i) Routine Inspection and Testing
         (ii) Troubleshooting and Diagnosis
         (iii) Repairs, Modifications and Overhauls

43. MAINTENANCE ORGANISATION
    e.g. (i) Maintenance Scheduling
         (ii) Spare Parts Stock Control
         (iii) Maintenance Decisions

44. WORK STUDY
    e.g. (i) Procedure and Sequence
         (ii) Recording Techniques
         (iii) Time Study
         (iv) Motion Study

45. INDUSTRIAL AND SAFETY REGULATIONS
    e.g. (i) Safe Working Conditions and Procedures
         (ii) Statutory Registers, Diaries and Inspection
         (iii) Third Party Liability

SECTION XI - ELECTRICAL SYSTEMS

46. ELECTRONIC DEVICES AND POWER SUPPLIES
    e.g. (i) Valve (Hard and Soft) Characteristics, Parameters and Frequency Response
         (ii) Transistor Configurations, Characteristics and Frequency Response
         (iii) Valve and Semi-Conductor Rectifiers
         (iv) Smoothing and Regulation
         (v) Controlled Rectifier Circuits
         (vi) Photo-Conductive and Photo-Voltaic Cells, Photo-Transistor Effect
47. CONTROL SYSTEMS FUNDAMENTALS
   e.g.  (i) Control System Components
         (ii) D.C. Servomechanisms
         (iii) A.C. Servomechanisms
         (iv) Hydraulic and Pneumatic Servomechanisms

48. CONSUMER INSTALLATIONS
   e.g.  (i) Wiring Systems
         (ii) Circuit Control and Protective Devices
         (iii) Earthing
         (iv) Metering

49. ALTERNATING CURRENT MACHINES
   e.g.  (i) Synchronous Motors
         (ii) Asynchronous Motors
         (iii) Commutator Motors
         (iv) Operations Analysis - Circle Diagram,
              Equivalent Circuits and Speed Control
         (v) Starting Methods

50. MOTOR CONTROL AND PROTECTION
   e.g.  (i) Protection Devices - Overload and Under-Voltage
         (ii) Starters and Remote Control
         (iii) Speed Control and Braking
         (iv) Drives and Couplings

II. STRUCTURE OF PRIORITY CURRICULUM CONTENT ITEMS*
   Suggested by Teaching Staff Specialists (in Production and
   Maintenance respectively) from a 50-Item Sample Curriculum Content
   for
   Higher (Four-Year) Diploma in Mechanical Engineering
   (Production Option (A) and Maintenance Option (B))

OPTION A - PRODUCTION

1. Parts Assembly Drawing and Design

2. Drawing and Design of Machine Elements

3. Jig and Tool Drawing and Design

4. Product Design

OPTION B - MAINTENANCE

1. Drawing and Design of Machine Elements

*Curriculum Content Items uniformly assigned a MINIMUM OF AVERAGE
UTILITY by all Heads of Departments.
II. APPLIED MECHANICS

NIL

1. Tribology
2. Mechanical Vibrations

III. FLUID TECHNOLOGY

NIL

IV. WORKSHOP TECHNOLOGY

1. Machinability
NIL
2. Machine Shop Practice
3. Material Joining Techniques
4. Foundry Planning
5. Metallurgy

V. INDUSTRIAL PLANNING ANALYSIS

1. Cost Estimating
NIL

VI. INDUSTRIAL OPERATIONS ANALYSIS

NIL

VII. SUPERVISION

1. Performance Appraisal
NIL

VIII. WORKS SERVICES

NIL

1. Plant Operations

IX. HEAT ENGINE SYSTEMS

NIL

1. Basic Thermodynamics
2. Air Conditioning
3. Refrigeration
4. Automotive Engines and Prime Movers

5. Automotive Vehicles

X. MAINTENANCE

1. Work Study
2. Maintenance Processes

2. Industrial and Safety Regulations

XI. ELECTRICAL SYSTEMS

NIL

IIII. STRUCTURE OF BASIC CURRICULUM OUTLINE*
Suggested by Departmental Specialists (in Production and Maintenance respectively)
from a 50-Item Sample Curriculum Content for Higher (Four-Year) Diploma in Mechanical Engineering (Production Option (A) and Maintenance Option (B))

OPTION A - PRODUCTION

1. Parts Assembly Drawing and Design
2. Drawing and Design of Machine Elements
3. Jig and Tool Drawing and Design
4. Product Design

OPTION B - MAINTENANCE

1. Drawing and Design of Machine Elements
2. Product Design

*Curriculum Content Items assigned a MINIMUM OF AVERAGE UTILITY on the basis of mean response in respect of both Options.
II. APPLIED MECHANICS

1. Materials, Stress and Strain
2. Beams and Shafts
3. Dynamics and Kinetic Energy
4. Tribology
5. Mechanical Vibrations

III. FLUID TECHNOLOGY

1. Fluid Mechanics
2. Hydraulic Machinery
3. Pneumatic Machinery

IV. WORKSHOP TECHNOLOGY

1. Machinability
2. Machine Shop Practice
3. Material Joining Techniques
4. Plastic Flow Techniques
5. Foundry Practice
6. Foundry Planning
7. Metallurgy

V. INDUSTRIAL PLANNING ANALYSIS

1. Cost Estimating
2. Production Scheduling

NIL
VI. INDUSTRIAL OPERATIONS ANALYSIS

1. Process Analysis  
2. Resource Analysis  
3. Statistics and Quality Control  
4. Productivity Analysis

VII. SUPERVISION

1. Effective Communications  
2. Human Relations  
3. Performance Appraisal  
4. Industrial Orientation

VIII. WORKS SERVICES

1. Plant Planning  

IX. HEAT ENGINE SYSTEMS

NIL

1. Basic Thermodynamics  
2. Applied Thermodynamics  
3. Air Conditioning  
4. Refrigeration  
5. Automotive Engines and Prime Movers  
6. Automotive Vehicles
X. MAINTENANCE

1. Maintenance Processes
2. Maintenance Organisation
3. Work Study
4. Industrial and Safety Regulations

XI. ELECTRICAL SYSTEMS

NIL

1. Consumer Installations