Available online at http://scik.org
Linguist. Cult. Educ. 1 (2012), No. 1, 117-140

APPLICATION OF BLOOM'S TAXONOMY OF EDUCATIONAL OBJECTIVES AS A PROBLEM SOLVING TOOL IN THE TEACHING-LEARNING PROCESS IN AN "ELECTRICAL ENGINEERING TECHNOLOGY" COURSE

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Abstract: Recently, there has been a shift from using lecture-based teaching methods in undergraduate engineering courses to using more learner-centered approaches and problem-based learning. Bloom's Taxonomy of educational objectives as a problem solving tool in the teaching of an electrical engineering technology course has been attempted as an innovative way of engaging students leading to active learning.

A questionnaire was administrated before and after the training session to assess the extent to which the participants are aware of Bloom's Taxonomy. Later, problem solving techniques were explained to the faculty participants and they were taken through different levels of Bloom's and corresponding possible test items in electrical engineering technology were given and discussed as a method of problem solving and as an instructional strategy.

A critical analysis of University term-end question papers were carried out to assess the percentage of questions in HOTS (Higher Order Thinking Skills) and feedback given to individual faculty. Even though the number of participants was limited to thirty three, considering the beneficial effects of this type of training programme on better understanding of the Bloom's Taxonomy and its different hierarchical levels, the method can be used as a problem solving tool in class room teaching-learning process, in an University setup. Examples and test items were taken from the subject area of electrical engineering technology however the methodology can be applied to other subjects as well.

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Received May 20, 2012

Keywords: Bloom's Taxonomy; Problem Based Learning; Higher Order Thinking Skills

. 1. Introduction

The pedagogic techniques practiced in many engineering colleges and technical institutions in India, though are aimed to meet the goal of cognitive development amongst the students, but often end up in meeting the requirements of an examination system designed to test the rote memory rather than developing problem solving skills. Learning is taking a back-seat in the total educational process. We, at Academic Staff College, have been successfully teaching and training our faculty following Bloom's Taxonomy and the revised Bloom's Taxonomy as the pedagogical model in all our FDP's (Faculty Development Programmes) and in the teaching-learning process. Progressively we are developing a "Creative Learning Process" as the pedagogical model emphasizing on HOTS (Higher Order Thinking Skills) in the students and teachers are adequately trained accordingly.

Of all instructional methods, lecturing is the most common and least effective (Felder, 1992). It has been shown that students recall 70% of the information presented in the first 10 minutes of a lecture and only 20% of the information presented in the last 10 minutes (Mc Keachie, 1986). Edgar Dale's cone of experience (Dale, 1969) links levels of effectiveness in learning to different methods of presenting course material. It has been established that students retain 10% of what they read, 20% of what they hear and 30% of what they see as visual images. Further, they retain much more of the material when their engagement is kept high, for example, by doing something (such as solving a problem, finding a solution, answering a question) rather than just reading about it.

Recently, there has been a shift from using lecture-based teaching methods in the engineering and technology disciplines to using a more learner-centered teaching such as problem-based learning. This shift is primarily fueled by the need for future engineers to demonstrate the use of higher-order thinking skills (HOTS) and problem solving, (Aman Yadav, 2011 April). In this context, application of Bloom's Taxonomy of educational objectives as a problem-solving tool in teaching-learning process is quite relevant.

HOTS (Higher-Order Thinking Skills) refer to the ability to collect, analyze and evaluate information and to formulate conclusions. For HOTS, students are required to develop and demonstrate the ability to think critically, analytically and creatively. Generally in engineering and technology courses, Application, Analysis, Syntheses and Evaluation are considered as higher order thinking skills.

Peer Instruction and Peer Tutoring:

Thomas K. Grose (2011, February) has observed that his students were merely memorizing facts and pouring them back reproducing solutions that were not really new. A series of tests that he administrated them clearly showed that they didn't understand the underlying concepts of what he was teaching them-even the most basic. Education, according to him, is assimilating information and being able to use that knowledge to solve new problems. The information learned by rote memory is quickly forgotten; but understanding is something students never lose. (Thomes K. Grose, 2011). He developed a novel, interacting teaching method for large lecture hall classes, followed by peer instruction that has over the past decade come into wide use around the world in a wide variety of disciplines. He teaches, by asking questions. Ahead of classes, students are assigned to read a certain text or watch a video, but in the class room itself, it is "questions and answers" time, and integral to the method is students teaching students, hence, the term peer instruction/peer tutoring. This method has helped the students to grasp concepts that once eluded them. Peer assessment and evaluation, as a process, can also work in large classes settings, if the class is split into a number of small focus groups.

When compared to traditional classroom learning or even self-study, peer learning creates stronger, more powerful learning experiences and accelerates the learning process of students. Being more collaborative and interactive, peer learning has gained immense popularity, both as an instructional strategy and as a problem-solving tool.

2. Importance of Problem Solving in Engineering Technology Education:

The engineering profession requires engineers to deal with uncertainty and solve complex problems of the field, sometimes with incomplete information/data. (Mills and Treagust, 2003). In addition, engineers need to be able to function as effective members of the team(s) and have strong problem-solving and communication skills (NAE, 2004). However, today's engineering graduates lack these skills and have difficulty in applying their fundamental knowledge to problems of practice. (Mills and Treagust, 2003, NAE 2005, Nguyen 1998).

2.1 Motivation

The authors have been organizing training sessions on "Problem Solving" and on "Bloom's Taxonomy of Educational Objectives" independently as separate entitles during the Faculty Development Programmes (FDPs) organized by Academic Staff College.

Strategies for creative problem solving as applied to chemical engineering reactor design has

been developed by Scott Fogler, et al and the approach cited (Scott and Steven, 1995) has given an impetus and motivation to the development of this concept viz. "application of Bloom's Taxonomy of educational objectives as a problem solving tool" which is being reported here. This paper is an outcome of the efforts made by the authors to integrate both these ideas viz. "Problem Solving" and "Bloom's Taxonomy of Educational Objectives" in developing and implementing an innovative approach in the teaching-learning process.

The course offering viz. "Electrical Engineering Technology" has been selected since this course is considered as an important common core subject in the University for all the disciplines of "electrical engineering", "electronics and instrumentation and engineering" and "electronics and communication engineering" and engineers of these disciplines are expected to grasp fundamental concepts of electrical engineering technology and their applications.

2.2 Problem Solving

"Problem Solving" need not be confined only to mathematics, science, engineering or technology related courses. It can be applied even to learn a new language they already know. The term "linguistic problem solving" has been cited in classroom research for language teachers for graduate students (Numa, 2000 and Lawrence 2000). The researcher has analysed the written responses of the students for a given task and has concluded that first "understanding" occurs and then "learning" is demonstrated.

Welby Ings, in his paper on "An assortment of small anomalies" (Welby, 2011) has observed that "if we place an emphasis on asking questions, then the students see themselves as the thinkers and resolvers of problems".

Aristotle has formulated the concept of Phronesis (Alan, 2001). Phronesis is a need for, and processing of new skills "involving developing the habits, abilities, thoughts, ideas and technical mastery (Garrison and Eros, 1997). Phronesis is the virtue of practical wisdom of knowing the task and carrying it out to solve a problem.

A problem is a situation, condition, or an issue that remains unresolved and makes it difficult to accomplish a desired objective. The situation, condition or issue is considered as a problem when an individual (learner), group (peer-learners) or class (all the students registered for a course) become aware of the significant difference between what is desirable and what is actually the situation. Trying to find a solution or an answer to a problem is known as problem solving. The "problem" in this context need not be confined to "numerical question(s)" only as normally understand in science and engineering courses. It can be any situation, condition of an issue as cited above.

The nature of an engineering degree is the application of theory to solve problems. This idea needs to be conveyed to students from semester one.

Problem solving is an hierarchical process by which a situation is analysed, workable solution arrived at and corrective action is implemented. The strategic steps involved are:

- ◊ **Defining** the problem (clarifying the situation, condition or issue)
- ◊ **Analyze** causes
- ◊ **Generate/Identify** alternatives/ideas
- ◊ **Assess** the alternatives in terms of its pros and cons
- ◊ **Select/decide** the most feasible alternative (solution)
- ◊ **Identify** the steps required to implement the solution
- ◊ **Implement** the solution, and
- ◊ **Evaluate** whether the problem is solved or not

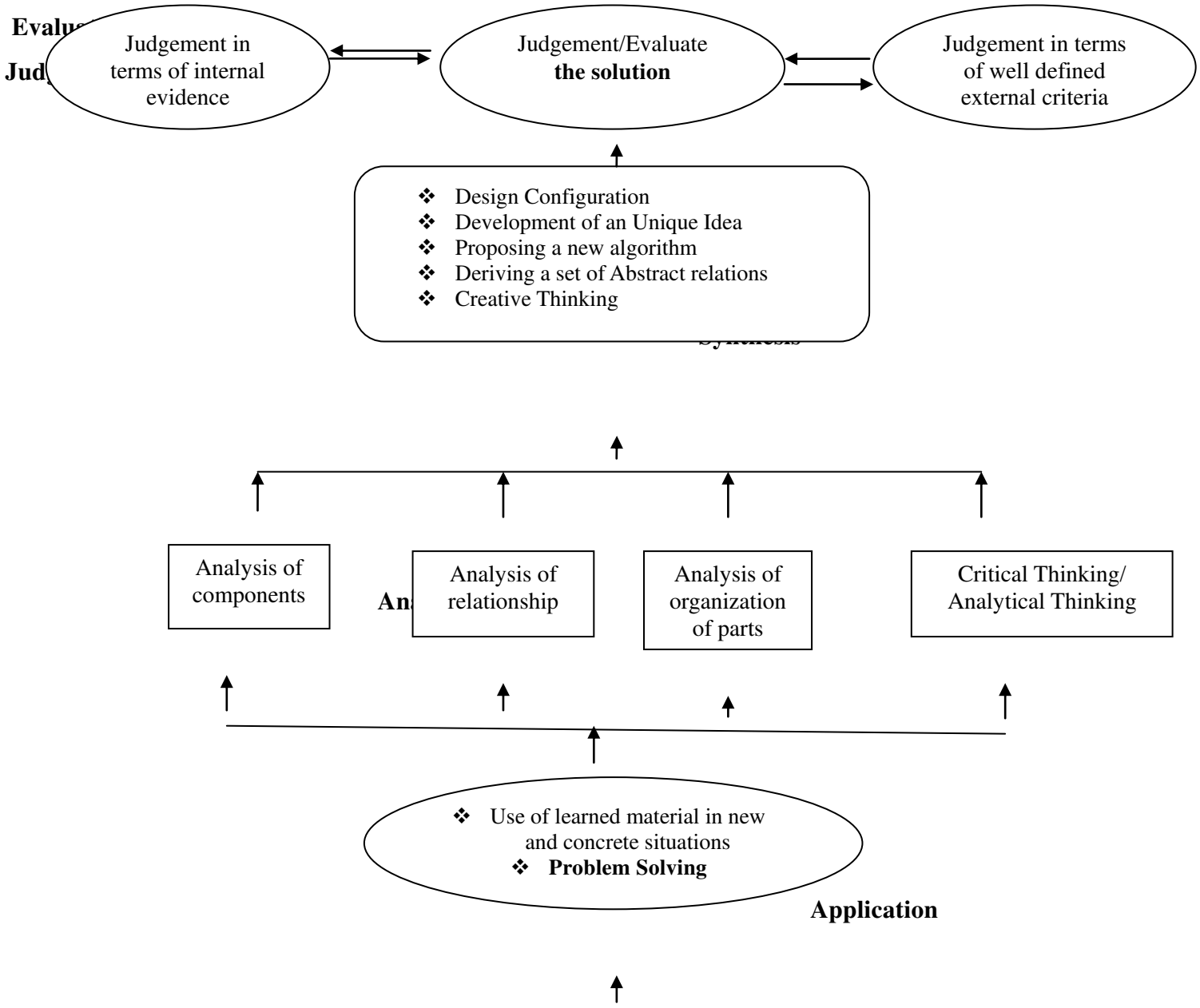
2.3 Problem Solving Techniques:

Olivier Serrat (2009) has cited many problem-solving techniques: Affinity Diagrams (organizing ideas into a common theme), Ansoff Matrix (understanding different risks/implications of different alternatives), Appreciating (understanding information extracted from facts), Appreciative Enquiry (looking at what is going right and solving the problems), Brainstorming (generating a large number of ideas to solve a problem), Cause and Effect Diagrams (identifying possible causes of problems), Critical Success Factors (identifying critical factors that really matter for success), the Five Whys Technique (quickly getting to the root of a problem); Flowcharts (understanding how a process works), Lateral Thinking (changing/inversing the concepts and perception), Reframing Matrix (examining problems from distinct viewpoints), Systems Analysis (identifying the various factors and understanding how they interact with and affect one another) and Root Cause Analysis (identifying the various factors and of problems or events).

3. Bloom's Taxonomy of Educational Objectives

Bloom's Taxonomy of educational objectives showing its relationships to problem solving at different levels is given Figure. 1.

Each level in the hierarchy is considered as a distinct skill with varying levels of difficulty involving varying levels of problem solving abilities. Each successive skill level calls for more advanced intellectual ability. However, some continuum exists at each level with the skill level below and above


Judgement in terms of internal evidence
Judgement/Evaluate the solution
Judgement in terms of well defined external criteria
Design Configuration
Development of an Unique Idea
Proposing a new algorithm
Deriving a set of Abstract relations
Creative Thinking
Analysis of components
Analysis of relationship
Analysis of organization of parts
Critical Thinking/ Analytical Thinking
Use of learned material in new and concrete situations
Problem Solving
Application

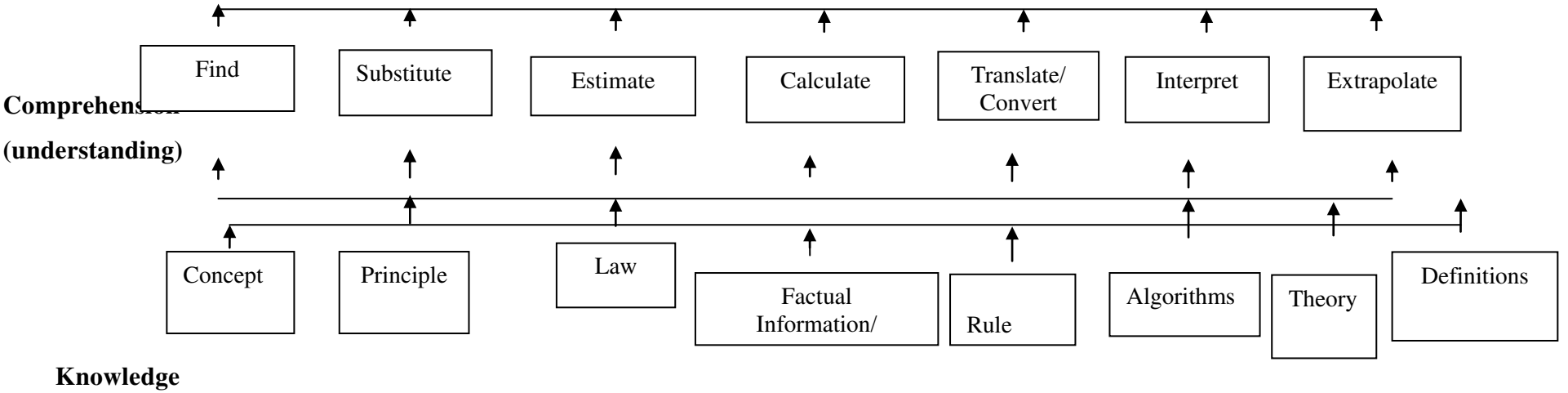


FIGURE 1: Bloom's Taxonomy of educational objectives showing its relationship to Problem Solving at different levels

4. Methodology

A training programme has been organized for the faculty of the School of Electrical Engineering wherein 33 faculty participants attended the programme. The extent of awareness regarding Bloom's Taxonomy was elicited by administering a questionnaire. After a few training sessions on Bloom's Taxonomy, a special faculty development programme was organized focusing on Bloom's Taxonomy as a problem solving tool.

Questionnaire administered to the Faculty before and after the training session on "Bloom's Taxonomy"and Analysis of responses received

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Your Name : Date :

Designation :

School :

Name of the Theory Subject/Course you are handling this semester Dec. 2011 – April 2012 _____

Name of the Programme and Branch : _____

	Before the training sessions	After the training sessions
• Have you attended any lecture/session on Bloom's Taxonomy earlier?	(no. of responses) Yes - Nil – No 33	All 33 responses were received
• Name some of the levels of Bloom's Taxonomy	None of the participants were aware of the no. of levels	31 participants recalled correctly that there are six levels
• Name some of the levels of Bloom's Taxonomy	None could answer this item	All the 33 participants were able to recall names of at least 3 or 4

		levels, though not as per the hierarchical level
• What is LOTS? Expand	None could expand LOTS	All the 33 participants could expand LOTS & HOTS
• What is HOTS? Expand	None could expand HOTS	
❖ Are you aware of alternate approaches to learning?	Yes 10 No 23	33 -Nil-

❖ If yes, list a few alternative approaches to learning.

Before the training, majority of the faculty members were not aware of alternative approaches to learning. Some of the participants (30%) even though they have not attended the training sessions are aware of some of the alternate approaches to learning such as use of role play, mind mapping, group discussion, seminars, models, use of charts, quiz, video clippings and animation.

After the training sessions, all the participants were able to recall a wide range of alternative learning approaches including problem-based learning and project based learning.

5. Discussion

Test items selected and problems given for solving for each level in the Bloom's Taxonomy, from the subject area of "Electrical Engineering Technology" are discussed below.

5.1 Knowledge

The remembering (and/or recalling from memory of previously learned material). Can the problem be solved simply by defining terms and by recalling specific facts, trends, criteria, sequences or procedures?

Knowledge is the lowest intellectual skill level. This level solves the type of problems such as recalling the types of electrical machines, generators, motors, etc.

Examples of knowledge level questions are:

•**State** Ohm's Law**.**

- **What** are the components of a d.c. generator?
- **Obtain** the equation for the current through any resistance in terms of total current, in a parallel circuit having 'n' number of equal resistances.
- **Define** Form Factor.
- **In which** units inductive reactance is measured?
- **State** and explain Kirchhoff's laws with example.
- **Choose** the correct alternative:

Magneto in an automobile electrical system is basically a(n)

(a) Transformer
(b) Condenser
(c) D. C. Generator
(d) A.C. Generator
(e) Magnetic Circuit

- **Choose** the correct alternative

Capacitors used in automobile electrical system provide a means of

(a) Storing electrical charge
(b) increasing the resistance of circuit
(c) providing an alternative source of power supply
(d) decreasing the resistance of a circuit

- **Is** Ohm's Law applicable for alternating current circuits also? Or, is it applicable only for d.c. circuits?
- **Which** scientist/who developed the concept of Inductance?
- **What** is the unit for inductance?
- In describing the operations of lifts/elevators used in high rise buildings **what** does the following abbreviations mean :

AC VVVF : _____

DC SCR : _____

DC PWM : _____

- **Fill in the blanks :**
  – We cannot analyze electric circuits using Ohm's Law only. We also need _____ current law and _____ voltage law.

– Given that the magnetic field of flux density is B Webers/m^2, effective length of the coil is l meters and the coil is carrying a current i amp., the force on the coil is equal to _____ Newtons.

– Principle of operation of a.d.c. motor is explained in the following sentence. **Fill in the blanks** with appropriate words.

When a current carrying conductor is placed in _____, it _____ whose direction is given by _____ left hand rule.

Other illustrative verbs/words used in posing knowledge questions are.

- **Who** has developed the laws concerning electrolysis?
- **Where** is a Commutator used?
- **Identify** the name of the theorem which states that "Maximum power transfer takes place from a generator into a load if the load impedance equal to that of the source independence".
- **What** formula will you use?

If R is the Resistance of the circuit in Ohms, L is the Inductance of the coil in the circuit in Henrys, and f is the frequency of the supply voltage in Hz, **what is the formula used** to calculate the Impedance of the circuit?

5.2 Comprehension

This is the second skill level and involves understanding of certain concept, principle, rule or law. Given a certain amount of information, such as a scientific principle can the problem be solved by selecting the most appropriate data and using it in conjunction with manipulation. Here emphasis is placed on formal manipulation where engineering students are required to manipulate the equations or formulae to arrive at the desired results. Comprehension also involves translation, interpretation, extrapolation of the equation, trend or any specific principle.

Examples of comprehension level questions are:

- **Given** the inductance value L=1 mH, can you manipulate the design equation / formula to **find** the _____ .
- **Compare and Contrast** the advantages and uses of differential and cumulative compound motor.
- **Construct** a plot of current as a function of time 't' in an inductive circuit.

Other Comprehension words are

- **Relate**: What is the relationship between Watts and Joules?

When we pay for our "electricity bill", we are paying for the power or the energy we consume?

- ***Show*** *how is the RMS value of a wave form calculated.*
- ***Distinguish between*** *a series wound motor and a shunt wound motor.*
- ***Reconstruct*** *the given circuit diagram shown in the figure.*
- ***Choose the correct alternative***

Alternative current (A.C.) is more widely used than D.C. for domestic and industrial power distribution, because

(a) Voltage and current can be altered using a transformer

(b) A.C. distribution losses are smaller

(c) A.C. power is cheaper

(d) D.C. produces more heating of the conductors.

A. *Understanding the Concepts*

- ***What*** *does I=V/R mean in words? Can you explain what that means, with a diagram?*
- ***What*** *is meant by phase angle?*
- ***What*** *are the various energy losses in a transformer?*
- ***How*** *are "phase angle" and "power factor" related? (**write** the relationship)*
- ***Extrapolate :*** *In a graph showing current build up as a function of time in an inductive circuit what is the current value at time t =Time Constant?*

B. *Problems involving thinking (higher difficulty level).*

Intermediate Calculation :

Example :

An A.C. Transformer type welding equipment draws a current of 70 Amperes from the 220 V line and the phase angle is 30^o. Calculate the power the welder draws from the mains.

Advanced Calculation :

Example

A coil having an inductance of 0.05 Henry and a resistance of 7 Ohms is connected to a

110 Volt, 60 Cycles A.C. power line. What current will flow through the coil?

5.3 Application

This is the third level in Bloom's Taxonomy. In engineering and technology programmes and courses this level is of significant importance. In engineering science and technology subjects many concepts, principles, rules, laws and equations are taught and students are quite comfortable in reciting them when they are asked to state them in the tests or examinations. But, if we ask them, what is the application of a specific formula, concept, rule or equation, they are unable to tell in which situation or circumstance the particular concept is used, where and how is it used? Under these conditions it is important that the teacher makes the learners aware of the different applications of a concept or the situations where a particular formula or equation is used, whenever a new concept is introduced. Faculty members, especially engineering teachers need to be sensitized on this critical aspect during the training sessions/faculty development programmes.

The skill involved at this level is recognizing which set of principles; rules equations or methods should be applied in certain situations, given the pertinent data or information. Once a particular principle is identified the necessary knowledge is recalled and an understanding of this helps in applying this principle in solving a problem.

Application level questions might be :

- **Make** use of the equation $z=\sqrt{R^2+(2\Pi fL)^2}$ and **solve** for the value of impedance of the coil given inductance of the coil is 0.05 Henry and resistance of the coil is 7 Ohms and supply frequency is 60 cycles/second.
- **Why** are the domestic appliances connected in parallel?
- **Choose the correct alternative:**

The electrical starter motor in an automobile vehicle is a

(a) Series-wound d. c. motor

(b) Shunt-wound d. c. motor

(c) Synchronous induction motor

(d) Servo motor

- A 12 Volt auto-battery of internal resistance 2.50 Ohms supplies power to a parallel connected bank of twenty 250 Ohms decorative lamps. **What** is the Voltage across any lamp?
- The resistance of the element of an electrical water heater designed for 220 V operation is 11 Ohms. At the rate of 15 Cents per kiloWatt hour (unit), **how much** it would cost in a month to operate this heater continuously for an 8 – hour day.

Other words or directive verbs are :

- **Apply** _____
- **Demonstrate** _____
- **Determine** _____
- **Illustrate** _____

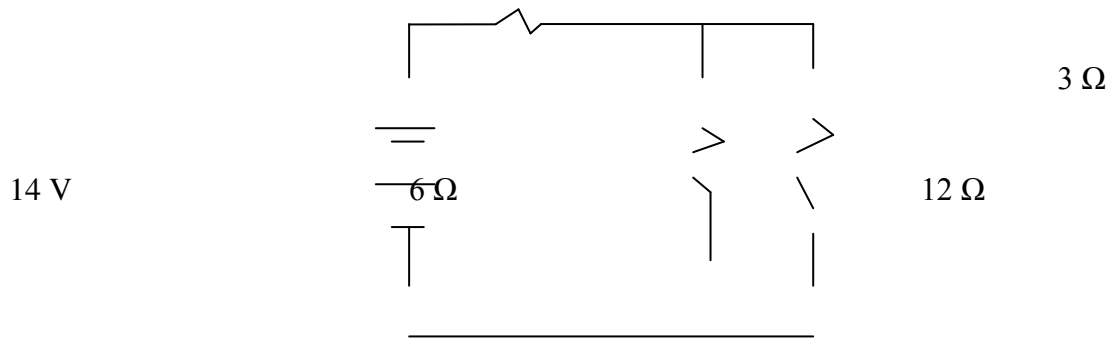
5.4

Analysis

Analysis involves identifying the various aspects, elements, components or constituents of the problem or situation and understanding their relationship amongst various constituents and its relationship to the whole problem. The hierarchy of the sub-problems or ideas is made clear. In analysis, the learner identifies the missing information, sometimes the redundant information and the contradictory information, if any. Once the analysis of the problem is completed, the various sub-problems are then reduced to one problem that can be easily solved.

Examples of analysis questions are:

What is the current in the 6 Ω resistor?



- **Derive** expressions for average and r.m.s. values of a sinusoidally varying current
- **What** conclusion(s) did you arrive at after studying/reviewing the experimental data?
- **Explain** the principle of operation of a d.c. generator.
- **Make** an analogy between electric circuits and magnetic circuits.
- **State** whether the following statements are True (T) or False (F)?
    1. A purely inductive circuit would have zero power factor
    2. A purely capacitive circuit would have zero power factor
    3. In a capacitive circuit, the current is lagging behind the voltage
    4. When power factor is zero, no current is flowing in the conducting wires
- **Derive** the expression for e.m.f. (Voltage) generated in a.d.c. generator from the fundamental principles.

Other words are :

- **Organise** …….,
- **Arrange** …….,
- **What are the cause of** ……..,
- **What are the components** of a power transformer?

5.5 Synthesis

This is combining or putting together of parts to form a new whole or a new entity. A synthesis problems would be one requiring the type, size and arrangement of an equipment necessary to meet the load requirements or formulating a new set of procedures using some of the standard elemental procedures or steps in a novel way. Given a fuzzy situation (i.e. a situation not clearly defined or not well defined), synthesis is the ability to formulate or synthesize a problem statement and/or the ability to propose a new method of testing. Once the various parts are combined or synthesized, a complete solution is feasible and is arrived at.

Examples of synthesis questions are :

- **How** will you explain the results of an experiment conducted for verification of Kirchoff's laws (both current and voltage)?
- **Propose** a test method to illustrate that the open-circuit voltage across the load decreases as the load current increases.

Other words are :

- **Devise** a method of speed control of a.c. shunt motor.
- **Design** a circuit for a stadium lighting/illumination system.
- **Develop** or **create** a new method for speed control of d.c. shunt motor.
- **What alternatives** would you suggest for speed control of d.c. shunt motor?
- **Suppose** we consider the economics of operation, which will be preferable for speed control of d.c. shunt motor; field control or armature voltage control?

5.6 Evaluation

This level in the Bloom's hierarchy of educational objectives is the highest one and is also referred to as "judgement".

Several alternatives or alternative solutions may be arrived at to solve a particular problem or a situation. These alternative solutions may have to evaluated against a set of well defined criteria Qualitative and quantitative aspects about the extent to which the solution satisfies the external criteria and the internal criteria can also considered in evaluating the appropriate solution.

Some of the criteria considered for evaluation of a solution may be :

- Extent to which the solution meets the desired expectations;
- Time frame for implementing the solution;
- Sensitize the people involved and making them understand the implications of the solution or new methodology (long range implication or its immediate effect) ;
- Cost involved; and
- Whether the solution arrived at is likely to lead to another problem?

Examples of evaluative questions are :

- **Are you justified** in concluding that _____?

Other words/directive verbs are :

- **What** is the right method that should have been adopted for testing the equipment?
- **Check** whether the electrical power distribution system will work under the set of given conditions?
- **Has** the problem of low voltage been really solved; If yes, to what extent?.....
- **Argue** on behalf of the solution arrived at or against it.
- **Which** is the best alternative and **why**?

For domestic electricity power distribution, **which is the best alternative?** a.c. supply or d.c. supply and **why?**

- **Give** a Ranking or Rate the Solution(s) in terms of their feasibility of implementation, cost incurred, and benefits likely to be accrued and any immediate effect?

Electrical engineering technology students are required to know, use and apply various theorems to solve problems concerning electrical circuits, appliances, electrical machines and equipment in their professional career. These theorems form the very basis or foundation of the electrical engineering technology. As an exercise,

statements of various theorems are given with one or two words to be filled in appropriately in the blank spaces provided (Appendix 1). A list of words to choose from is given in Appendix 2.

Choosing the most appropriate words was somewhat a difficult task for the faculty themselves. They have to carry out this task in two or three attempts by going over the theorems, choosing the appropriate word words and satisfying each statement. This calls for problem solving ability at the higher level involving combination of analysis, synthesis and evaluation skills in an integrated manner. Faculty members evinced keen interest in doing this task, discussing and arguing about the choice of words to complete each statement.

6. HOTS (Higher Order Thinking Skills)

HOTS refer to the ability to collect, analyze and evaluate information and to formulate valid conclusions. For HOTS, students are required to develop and demonstrate the ability to think critically, analytically and creatively. Rote learning is often deceptive and passes off as apparent learning (in contrast to real learning), but does not let students develop higher order thinking skills (HOTS) such as critical thinking, creativity and application. Students who do not develop these skills also will not be able to think rationally and discriminate between good or bad in various social and ecological issues being faced today (Vyjayanthi Sankar, 2011 December). Generally in engineering and technology courses, Application, Analysis, Synthesis and Evaluation (Judgment) are considered as higher order thinking skills.

In the final phase, an analysis of term-end question papers set in different electrical engineering courses was made. There is an expectation that % of questions/test items involving HOTS (Higher Order Thinking Skills) should be about 70-75% and the balance 25%-30% could be from the levels dealing with knowledge and comprehension. The proforma used for such an analysis in given in Appendix 3. The % of HOTS questions in the University term end question papers set by faculty in respect of various courses is shown below.

S. No.	Course Title	% of questions involving HOTS (Higher Order Thinking Skills)
1.	Computer Organization	13% (*)
2.	Engineering Physics – I	55% (*)

3.	Signals and Systems	65% (*)
4.	Software Project Management	95%
5.	Compiler Design	45% (*)
6.	Information Security	10% (*)
7.	Digital Logic Design	77%
8.	Automobile Engineering Technology	35% (*)
9.	Telecommunication Switching Systems and Networks	58% (*)
10.	Control Systems	56% (*)
11.	Machine Tools Technology	35% (*)
12.	Mathematics	77%
13.	Computer Programming	70%
14.	Electrical Engineering Technology	80%
15.	Java Programming	0% (*) (All the test items were in knowledge and comprehension level only)
16.	Object Oriented programming	20% (*)
17.	Data Structures	48% (*)
18.	e-commerce	86%

There is an expectation that % of questions/test items involving HOTS should be about 75%.

- ❖ Indicates that the faculty should modify his/her classroom instructional strategies so that questions pertaining to HOTS could be asked. Faculty members were accordingly given guidance in this respect.

Personalized/individual guidance was given to faculty members as to how they can

modify their instructional strategies so that high order thinking skills can be cultivated amongst their students and question papers can be set with the test items accordingly

7. Conclusion

In pedagogy, instructional strategies and educational research, "problem solving" and "Bloom's Taxonomy of educational objectives" are considered as separate entities and are dealt with accordingly. Herein, an attempt has been made to integrate both these ideas resulting in "application of Bloom's Taxonomy of educational objectives as a Problem Solving tool" in the teaching-learning process and this has been successfully implemented in respect of a course in an engineering discipline.

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Appendix 1

Theorems in Electrical Engineering Technology

(These theorems form the foundation of electrical engineering technology. Complete the statements by choosing the right words from the list of words given.)

(1) Superposition theorem for electrical circuits states that in any branch of a bilateral linear circuit having more than one independent source equals the algebraic sum of the responses caused by each independent source acting along, while all other independent sources are replaced by their _____ . _____

(2) **Reciprocity theorem** states that if a voltage source in one branch of a reciprocal network produces a current I in another, then if the voltage source is moved from the first to the second branch, it will cause the _____ current flow to the first branch, where the voltage source has been replaced by a _____.

(3) Thevenin's theorem for linear electrical networks states that any combination of voltage sources and resistors with two terminals is electrically equivalent to an _____ in _____ with a resistor R.

(4) **Norton's theorem** for linear electrical networks states that any combination of current sources and resistors with two terminals is electrically equivalent to an _____ in _____ with a resistor R.

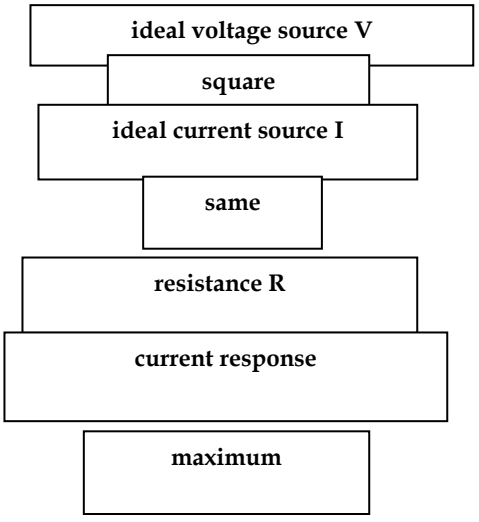
(5) **Maximum power transfer theorem** states that, to obtain _____ power from a source with a finite internal resistance, the _____of the load must be made the _____ as that of the source.

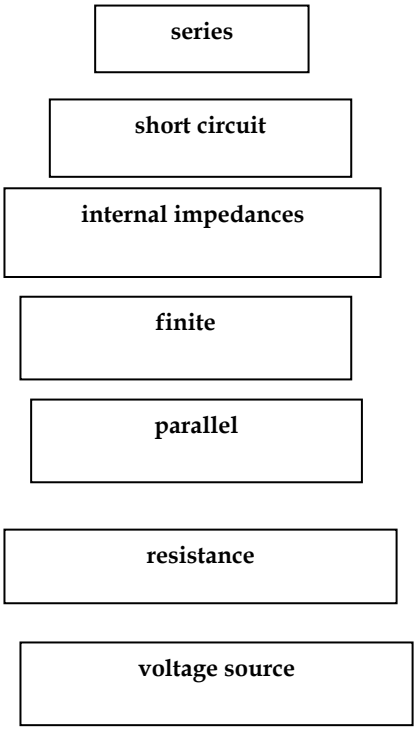
(6) **Compensation theorem** states that if the resistance R of a branch in a network in which a current I flows is changed by a _____ amount ∂R, then the change in the currents in all other branches of the network may be calculated by inserting a _____ of I∂R into that branch with all other voltage sources replaced by their internal resistances.

(7) **Joule's law** states that when a current I is passed through a resistance R, the resulting power P dissipated in the resistance is equal to the _____ of the current I multiplied by the _____.

Appendix 2

List of words to choose from to complete the statements (given in Appendix 1)




series
short circuit
internal impedances
finite
parallel
resistance
voltage source

Appendix 3

Subject /Course Title : _____ _____

Analysis of Semester-End Question Paper With Respect of Bloom's Taxonomy
Date :

(numbers indicate the marks allotted to the question)

	LOTS		**(Higher Order Thinking Skills (HOTS)**			
Test Item/ Question No	**Knowledge**	**Comprehension**	**Application ***	**Analysis**	**Synthesis**	**Evaluation / Judgement**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
Total :						

	Actual	**Desirable**
Know + Comp =	%	25% - 30% (maximum)
App + Ana + Syn + Eva =	%	70 - 75%

* For the analysis, "Application" level is considered as an Higher Order Thinking Skill. In engineering education, students study many principles, rules, laws and equations and it is desirable that they also know and learn their practical applications in different areas of engineering and technology.1