

A complete eLearning solution on Electrical Machines

The collage features several educational resources:

- VLab-I**: A screenshot of a virtual lab interface showing a graph of Electric Power and Power Dissipation versus Time, with control sliders for Exciter Permeability, Field Voltage, and Number of Poles.
- e-Tool**: A menu titled "E-Tools on Electrical Machinery" with options for Winding, Singly excited EMEC, Doubly excited EMEC, and Magnetic Circuits.
- e-Book**: The cover of "Principles of Electrical Machinery" by Dr. Praveen Kumar, featuring a diagram of a synchronous motor with Phase A, Phase B, Phase C, and Rotor.
- e-Quiz**: A screenshot of a quiz interface titled "Library of available Questions" with a table of question counts.
- VLab-II**: A screenshot of another virtual lab interface with a blue and orange background.

Question Type	Count
Easy Questions (E)	422
Medium Questions (M)	367
Hard Questions (H)	301

Legend: E = Easy, M = Medium, H = Hard



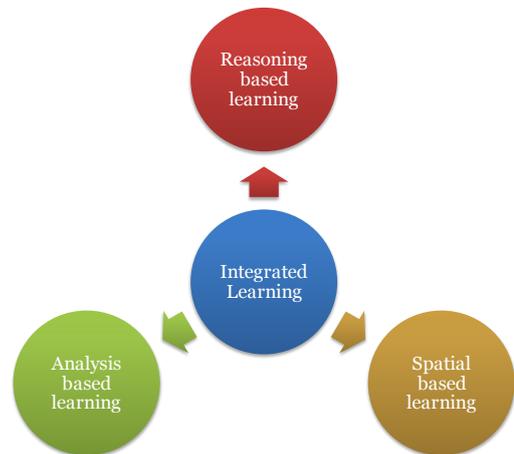
E-Learning Environment for Electrical Machine

Interactive learning tool is making significant changes in fundamental process of engineering education whether it is learning or teaching. The multidimensional benefits including the spatial ability development, are being realized by both teachers and students.

- *Integrated Learning*
- *Inspires Imagination*
- *Concept Visualization*
- *Problem based learning*

Product Portfolio

- *Interactive Ebook: Principles of Electrical Machine.*
- *Virtual Lab I : Basic Lab*
- *Virtual Lab II: Advance Lab*
- *eQuiz: Question Bank*
- *eTool: Interactive Exercise*



System requirements

- *PCs with window XP or higher version of OS*
- *.Net framework*
- *Web Browser: Google Chrome*
- *Adobe flash player*





Product Portfolio

e-Book

- 8 Chapters
- 600 Figures
- 800 equations
- 60 2D animations
- 19 3D Animations
- 20 Solved examples

Basic Virtual Lab

- Concepts of reluctance, flux, flux density and mmf.
- Induced emf in a single coil.
- Induced emf in two coils full pitched.
- Induced emf in two coils short pitched.
- Basics of equivalent circuit
- Speed control using variable frequency
- Voltage/frequency speed control

Advanced Virtual Lab

- Advanced version of virtual lab.
- Focusing on the same set of problems
- 5 levels of complexity
- Skill used: Calculations, Comparison and reasoning
- Force student to use all level of skills from reasoning to calculation and help them to remember relevant formulas

e-Tools

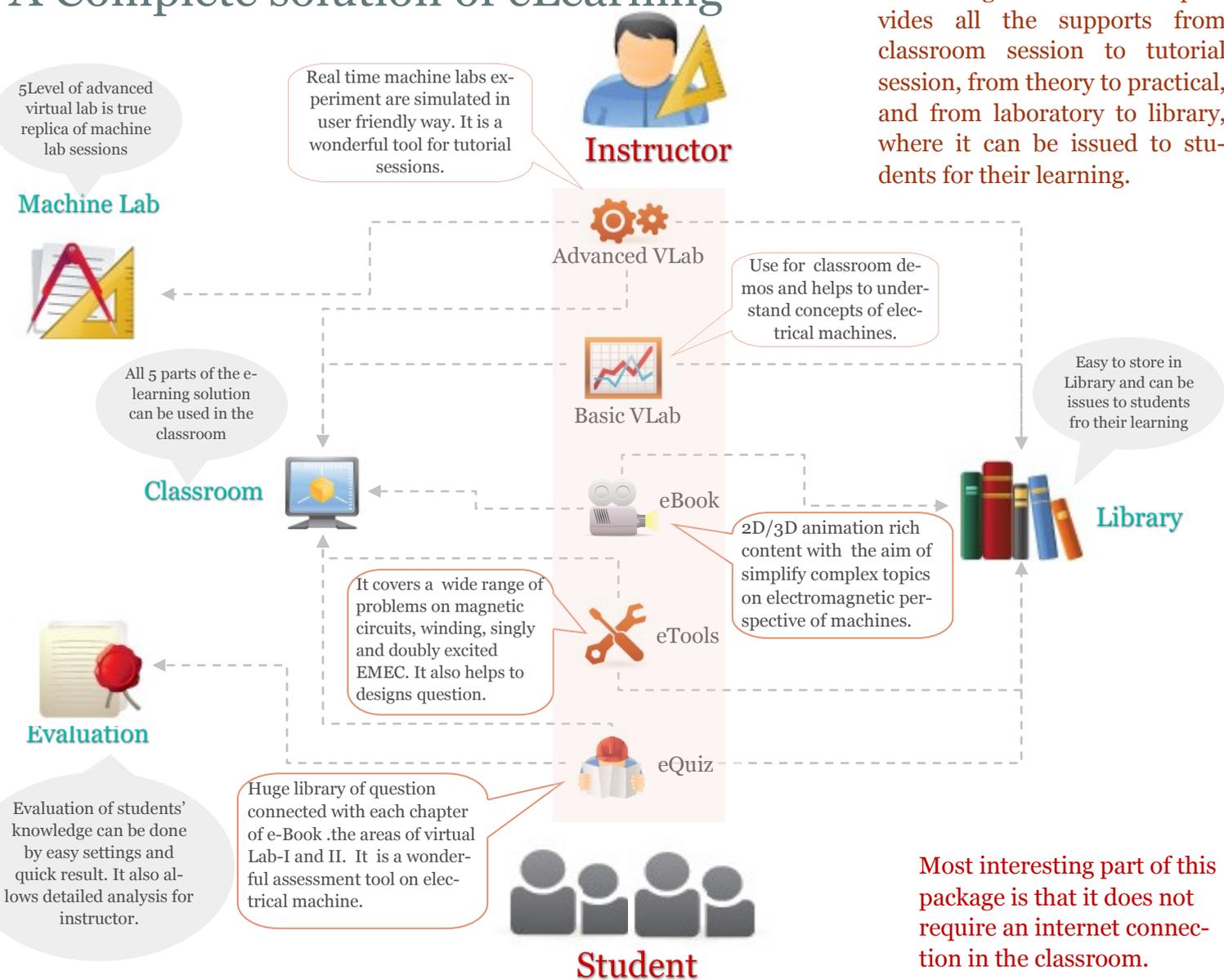
- To learn electrical machine design
- 28 different winding schemes
- 13 types of magnetic circuits
- EMEC for singly excited system
- EMEC for doubly excited system

e-Quiz

- 1100 Unique multiple choice problems.
- Three Level of Difficulties i.e, easy, medium and hard.
- Adaptive mode to select different difficulty questions automatically.

A Complete solution of eLearning

e-Learning environment provides all the supports from classroom session to tutorial session, from theory to practical, and from laboratory to library, where it can be issued to students for their learning.

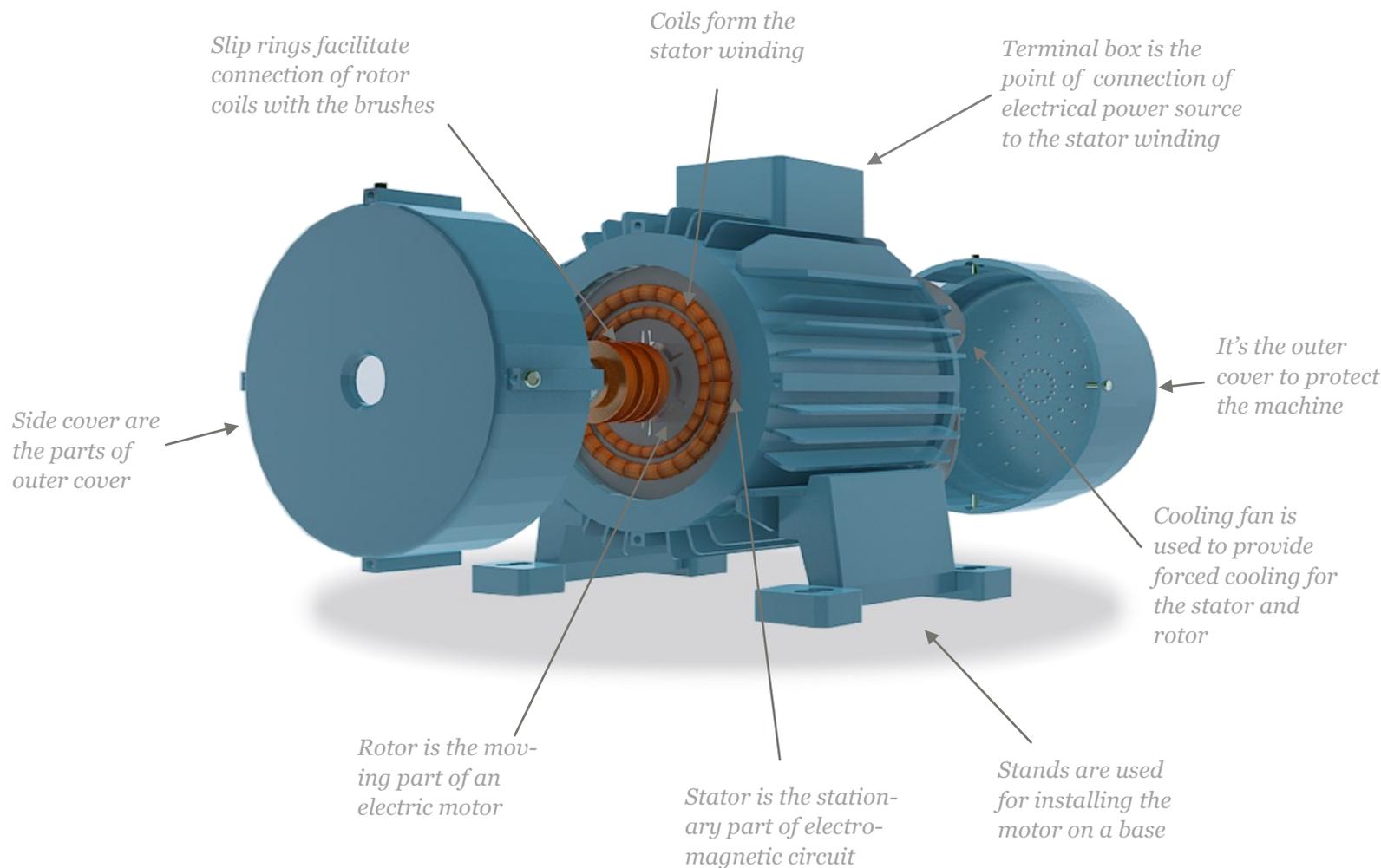


E-learning environment on electrical machines is a complete package to build concepts, to learn and to practice on electrical machines. The greatest advantage of this package is, its interactivity and fun-learning nature, which makes complex topics simple. It gives feeling of a well-equipped classroom, enriched with modern tools using advanced technology. e-Book, VLab - I (basic virtual lab), VLab - II (advanced virtual lab), e-tool and e-quiz, all the five components are complementary to one another.

This package converts a traditional classroom to modern classroom. The 2D and 3D animations available in the e-book help students to improve their visualization on the topics. On the other side, the highly interactive **e-book**, which can be used for slide presentation is an excellent tool for the instructors in the classroom. E-book has several easy navigation ways as well, which students really enjoy while using it.

Virtual labs compliment e-book by creating virtual environment of machine labs. Basic version of virtual lab is Vlab-I, that supports e-book as a classroom demo tool. It shows interdependency of different parameters by the representation of graphs simply by drag and click event. Whereas, VLab-II is advanced version of the virtual lab. It provides real time machine experiment with the help of simulation. Thorough realization of problems is possible using it, which is an excellent tool for tutorial sessions.

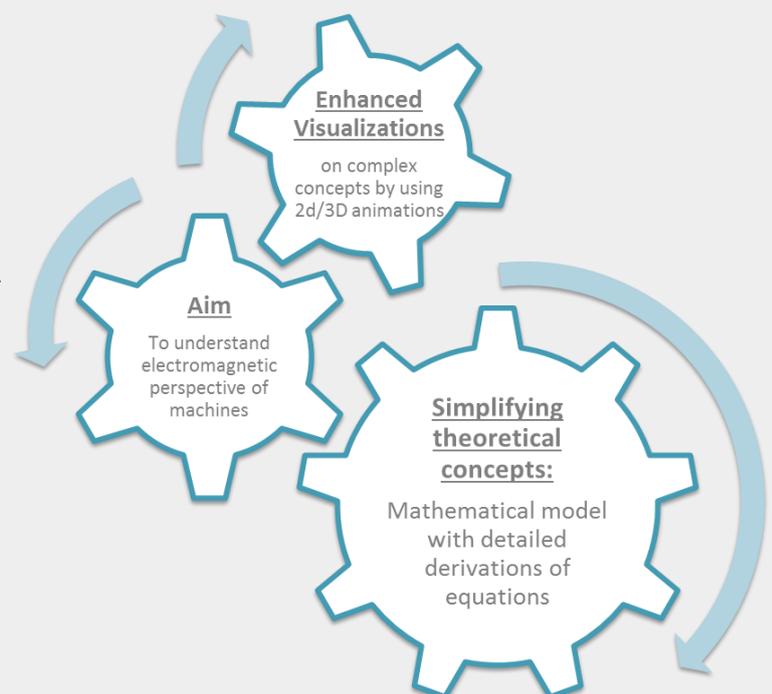
A cylindrical rotor synchronous motor



Keeping in view of difficulties that might occur in explaining some complex topics in e-book, ***e-tools*** are introduced. It focuses on complex topics like magnetic circuits, winding, singly and doubly excited EMEC .

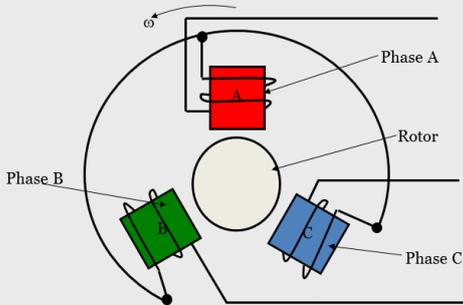
Evaluation of all the topics learnt through this e-learning solution is another function of it, which is done through ***e-quiz***. Its flexible set up for different difficulty levels enables students to answer it and delivers instant result as well. Moreover, instructors can analyze each students answer script and work on the weak areas.

Solutions of Advanced Virtual Lab and e-Quiz are protected only for the instructor. Besides these, instructor manuals are also given as separate copy. These manuals make the package easier to operate.



Principles of Electrical Machinery

Dr. Praveen Kumar



E-BOOK

The e-book is designed in order to provide a comprehensive idea on electrical machines.

It is an interactive book with animation-rich content on electromagnetic perspective of machines. Aim of the e-book is to simplify complex topics using high quality 2D and 3D animations. Various figures and equations help students to build clear understanding on theoretical concept.

This book develops the foundation in the fundamentals from electromagnetic point of view. The link between electromechanical energy conversion and equivalent circuits is explained in it. Mechanism of developing electrical equivalent circuits of machines is also explained in it. The 2D and 3D animations shows performance and operation of electrical machines.

Post-it and text highlighters offers advanced level of interactivity to it.

TABLE OF CONTENT

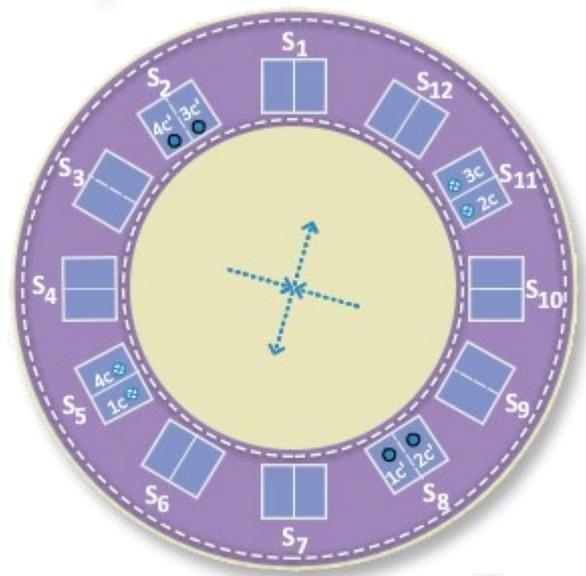
- ⇒ Chapter 1: Fundamentals of Electric Circuits.
- ⇒ Chapter 2: Principles of Magnetic Circuits
- ⇒ Chapter 3: Principles of Electromagnetic Energy Conversion
- ⇒ Chapter 4: Electromagnetic Energy Conversion in Doubly Excited Systems
- ⇒ Chapter 5: Working Principles of Electrical machines
- ⇒ Chapter 6: Fundamentals of Induction machine
- ⇒ Chapter 7: Speed Control of Induction Motors

BENEFITS

- ⇒ As a text book by Student
- ⇒ As a presentation slide by instructor due to its elegant look
- ⇒ As a reference for Virtual Lab, etools and equiz
- ⇒ As a helping material with animations and figure

FEATURES

- ⇒ Focus on various solved examples and boxes that does not break the flow of text
- ⇒ 500 detailed figures on...
- ⇒ 60 High quality 2D animation
- ⇒ 20 3D animations on electric motors, their characteristics and electromagnetic properties



A 2D Animation: The direction of magnetic filed produced by coils of phase C in a four pole machine.

E-book: Advanced level of interactivity

Interactive Table of Content

Text highlighter

All time navigation bars with sitemap and special edit tools

ePost-it with date time and details

Home

Chapters

Figures

Boxes

Examples

Tables

Animations

Jump to Page go

Erase All

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Important for next assignment

Figure 5.3b

At time instant 1, the currents of each phase are

$$i_a = I_m ; i_b = -\frac{I_m}{2} ; i_c = -\frac{I_m}{2}$$

where

I_m = maximum value of the current

Since, i_b and i_c are negative, crosses must be shown in coil rule **use the max distribution** as shown in figure 5.3b. In magnitude to flux.

At instant 2, the currents are

$$i_a = \frac{I_m}{2} ; i_b = \frac{I_m}{2} ; i_c = -I_m$$

The magnetic flux distribution created by the currents at inst

$$i_a = -\frac{I_m}{2} ; i_b = I_m ; i_c = -\frac{I_m}{2}$$

Figure can be seen on the same page

Figure 5.3b: Magnetic at time instant t1.

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Activate Windows
Go to PC settings to activate Windows.

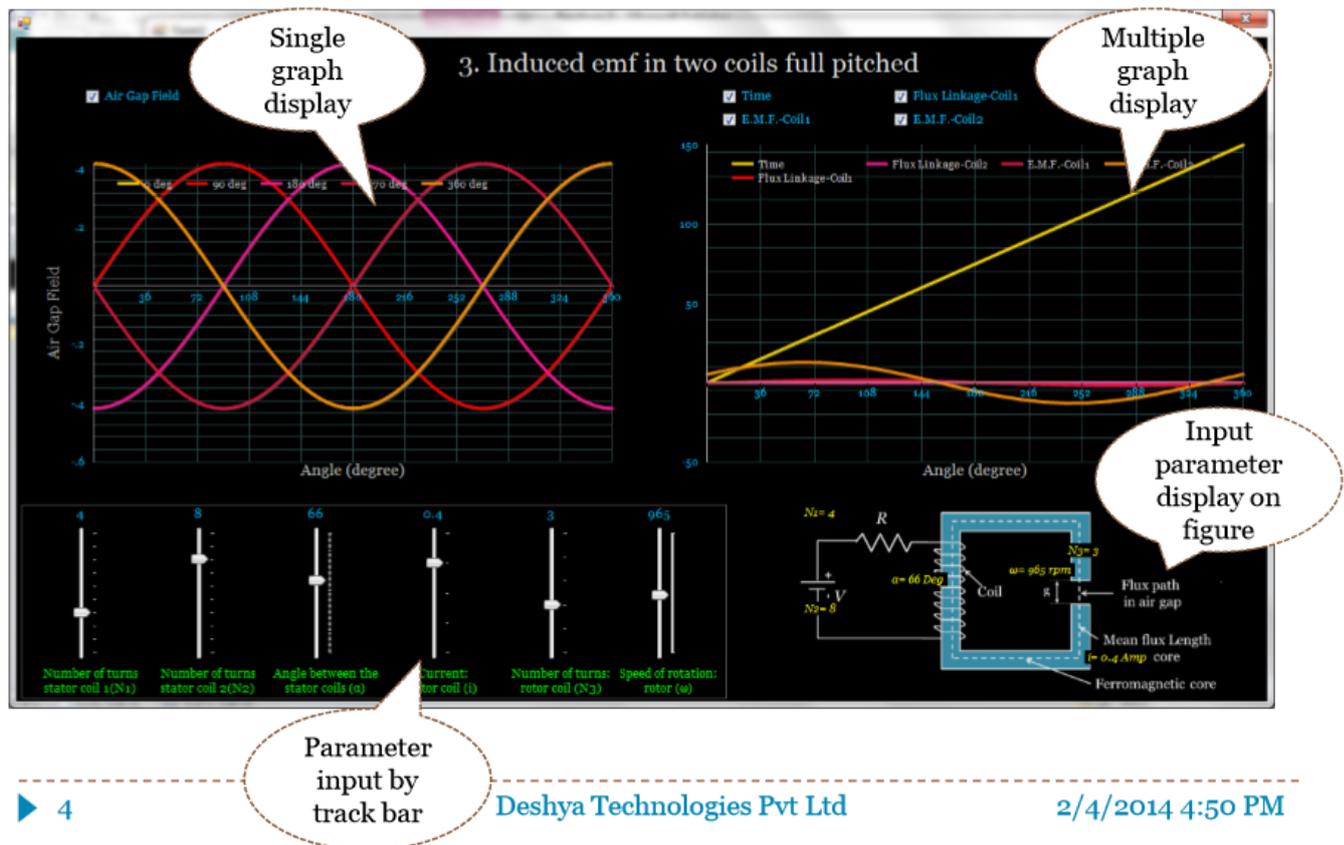
3d Animation: Eddy current in laminated

- The green rectangular shell is made of a non-magnetic material such as plastic.
- Copper coil are wrapped around the shell and the shell given mechanical strength to the coil
- The coils are connected to an alternating current source.
- The alternating current through the coil creates an alternating magnetic field.
- When a test material (ferromagnetic material) is placed in the shell it is exposed to alternating external magnetic field.
- As a result of the alternating magnetic field, circular current is induced within the material due to faraday's law of induction.
- This circular current is known as eddy current or Foucault current
- In this animation the bulk material is laminated into 5 slabs.
- Each slab is electrically isolated from its neighboring slab.
- Due to the lamination the effective resistance of the material increases and hence magnitude of eddy current decreases.

BASIC VIRTUAL LAB - VLAB-I

unique analytical tool for classroom demos. Variations of the parameters with drag and click events are possible which gives quick results. Instructor has a choice to choose single view or multiple view graphs depending on his methodology. Above all, it is an excellent handy tool to be used at classroom or lab.

VLab - I helps to build clear concepts about fundamentals of electrical machines. The fast and efficient representation of graphs makes it an



FEATURES

- ⇒ The parameters can be varied simply by moving the slider bars
- ⇒ Play with parameters and see real time relation in single view or double view charts.
- ⇒ Following problems are explained by it
 - * Concepts of reluctance, flux, flux density and mmf.
 - * Induced emf in a single coil.
 - * Induced emf in two coils full pitched.
 - * Induced emf in two coils short pitched.
 - * Basics of equivalent circuit
 - * Speed control using variable frequency
 - * Voltage/frequency speed control

BENEFITS

- ⇒ Fast and efficient : Save time in drawing complex graphs and figures on board during classroom teaching.
- ⇒ Interactivity easy to use . Results are few clicks away.
- ⇒ Comparative analysis : play with input parameters and observe real time changes on various outputs.
- ⇒ Handy: can be used by instructor/student , can be used at classroom/LAB
- ⇒ Conjunction with advanced virtual lab.
- ⇒ Fun learning: Complex topics can be learnt by playing with various parameters

ADVANCED VIRTUAL LAB—VLAB-II

Advanced virtual lab enables application of the concepts learnt in the classroom. In a way, it is a practical application of learnt theories that sparks imagination and helps to understand theoretical equations and formulae. It can be used as tutorial sessions. This provides a virtual environment of performing various operations, which is otherwise not viable. Applications of numerical techniques can be easily understood using advanced virtual lab. VLab - II contains thought-provoking hints for wrong answers.

Level V

Reasoning level—No calculation but thoughtful question based on previous levels.

Level IV

Sensitivity analysis level — Impact of change in input parameters on the results obtained in level II.

Level I

Basic level—Read and understand the problem - Intuitive application of theory learnt



Level III

Analysis level — Comparison of different charts resulted from level 2 calculations - Reasoning session based on level II.

Level II - Input and calculation level — User input to design your own problem configuration—Perform calculation based on learnt formulas

1. Concepts of reluctance, flux, flux density and mmf - Level 2

SN	Inout Voltas	Time	Current	Voltase Acr	Resistance	Voltase acrc	Electric Pow	Power dissip
1.0000000	100.0000...	0.0002511	2.0000000	2.0000000	1.0000000	100.0000...	200.0000...	4.0000000
2.0000000	100.0000...	0.0005022	3.9600000	3.9600000	1.0000000	98.00000...	396.0000...	15.6816000
3.0000000	100.0000...	0.0007532	5.8808000	5.8808000	1.0000000	96.04000...	588.0800...	34.5838086
4.0000000	100.0000...	0.0010043	7.7631840	7.7631840	1.0000000	94.1192000	776.31840...	60.2670258

Q1.6c. Please calculate Power absorbed by the inductor. Go to Next Question

First Value: Input_Voltage Time Current Voltage_Across_Resistor Resistance Voltage_across_inductor Electric_Power Power_dissipate_resistor

Second Value: Input_Voltage Time Current Resistance

Buttons: +, -, ×, /, 1/x, sqrt

Chart: Time vs Power_dissipate_resistor

Tool give base result from user input

Table can be copied and saved in MS Excel for later use

These options force student to remember correct formula. If they forget then hints guide them to the right path.

Charts are automatically saved on the hard disk

MULTILEVEL LEARNING

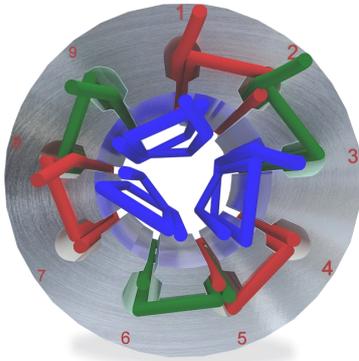
Skill used	Level1	Level2	Level3	Level4	Level5
Calculation		✓		✓	
Comparison			✓	✓	
Reasoning	✓		✓	✓	✓

BENEFITS

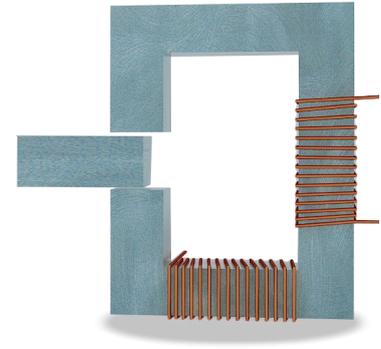
- ⇒ Force student to use all level of skills from reasoning to calculation and help them to remember relevant formulas
- ⇒ Compliments to the ebook and solidifies the theoretical foundation
- ⇒ Advanced version of Vlab I by focusing on the same set of problems
- ⇒ Create table and hundreds of graphs which can be stored on hard disc for later use.

E-TOOL

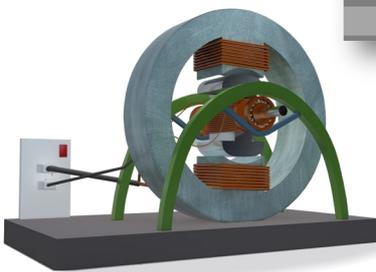
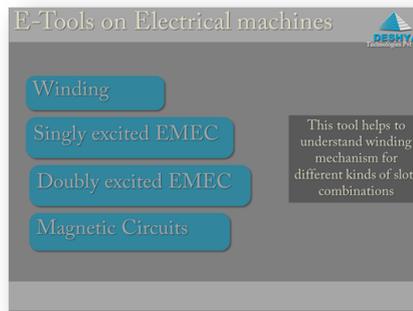
E tools: - It focuses on most of exciting problems of electrical machines, such as magnetic circuits, winding, singly as well as doubly excited EMEC. E-tools enhance those areas, which were difficult to explain through e-book. It also helps to design questions on the above mentioned areas. Different kinds of magnetic circuit are explained by using 3d hints. On windings, it helps student to understand the different winding schemes. Students will have clear concepts of all the areas of electrical machines. Difficult calculations involving relation between different form of energy and analysis of EMEC devices are explained in e - tools.



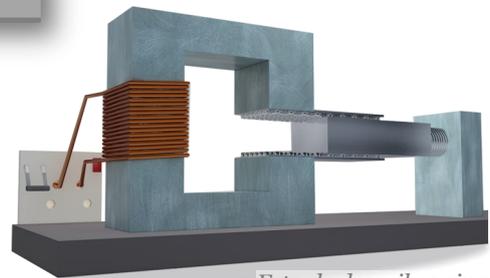
Several windings schemes using different poles and slots are explained through e - tools; Total scheme : 28



Electrical machines are generally built to utilize the magnetic field in the electromechanical energy conversion process. Total Number of Problems: 13



Doubly excited coils that produces reluctance as well as electromagnetic torque are explained by using an example



E-tools describes singly excited coils which produces reluctance torque; Total Number of Problems: 3

FEATURES

- ⇒ It helps the student to apply their learning from classroom demos to lab tutorials into real time applications such as Magnetic circuits, Winding schemes, Singly excited systems, Doubly excited systems.
- ⇒ For each category, concepts are explained in consecutive simple steps.
- ⇒ Guides the student towards correct solution using 2D and 3D animation based hints.

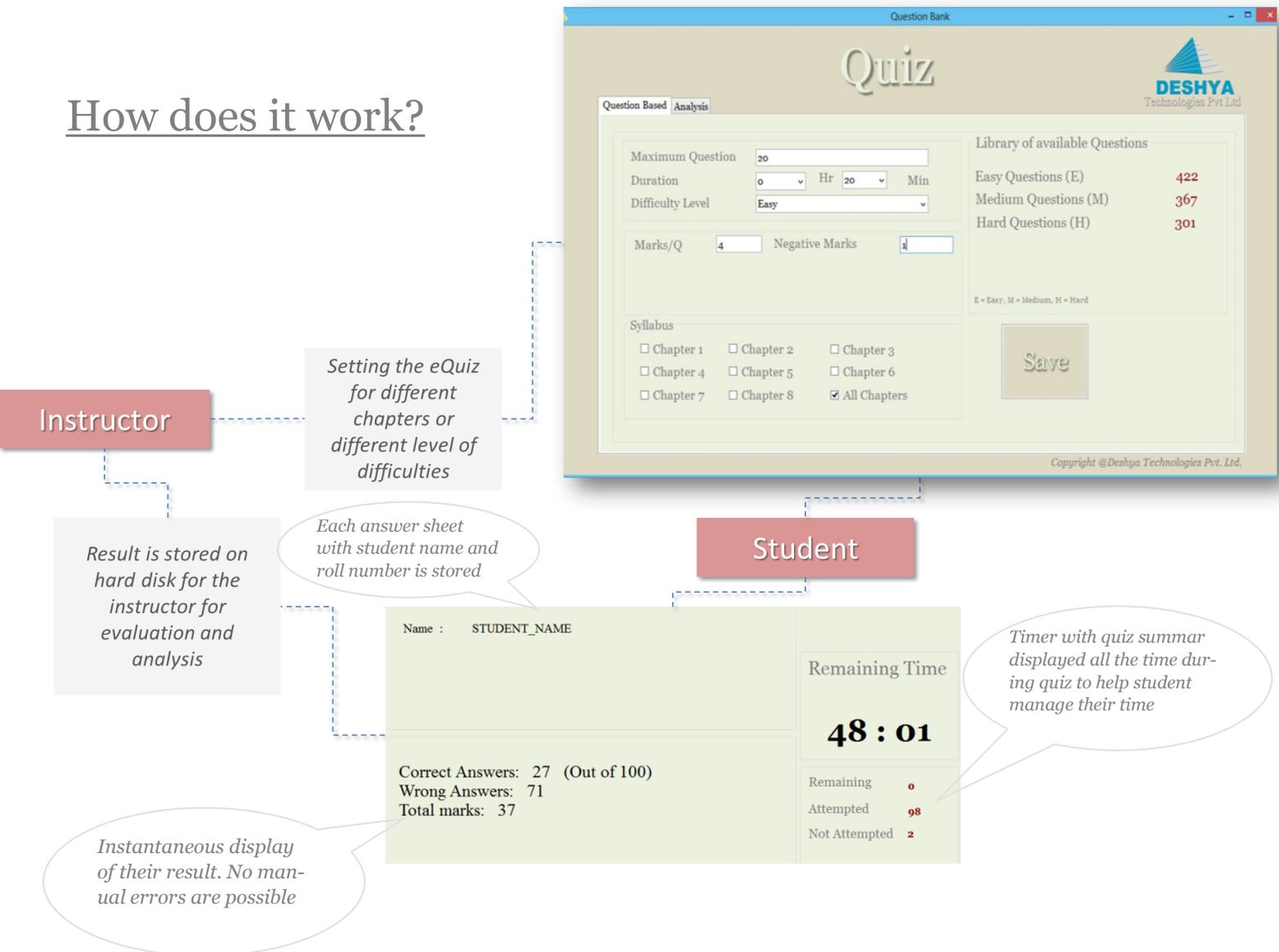
BENEFITS

- ⇒ Enables the student to design his/her own question (Using input parameters).
- ⇒ Students learn to make winding by using different combinations of number of slots and number of poles.
- ⇒ Fundamental difference between singly excited and doubly excited systems are explained here.
- ⇒ It creates a virtual environment of machine workshop

E-QUIZ

E-quiz has a huge question bank, which covers each topic of e-book and all the areas of virtual Lab - I and II. It is a wonderful assessment tool on electrical machine with easy settings, quick result and also detailed analysis for instructor. Easy setting for different difficulty levels add new level of flexibility and make it an interesting assessment tool. Number of questions from a specific chapter with time limit can be set quickly for the class quiz. During the quiz, the overview of remaining time, number of question remained and attempted, helps student to manage their time.

How does it work?



FEATURES

- ⇒ Question Bank of 1100 unique multiple choice problems.
- ⇒ Three Level of Difficulties i.e, easy, medium and hard.
- ⇒ Possibility to choose adaptive mode.
- ⇒ Timer is the embedded in the quiz to make it time bound.
- ⇒ Its possible to set positive and negative marks for right and wrong question.

BENEFITS

- ⇒ The instructor can configure an examination using e-quiz.
- ⇒ Possibility of analyzing the students answer script to find out weak areas.
- ⇒ Add convenience to use as classroom quiz.
- ⇒ Answer sheets for each student with their name and roll number can be used for the cross checking of their marks..

Deshya Technologies Pvt Ltd
TIC-04,
Technology Incubation Centre
IIT Guwahati
Assam - 781039



Phone: +91(0361) 2583196
E-mail: contact@deshya.com
Website: www.deshya.co.in