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Experimental Module on 3 Phase Induction Motor Coil Connection for Vocational Study

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This research is to develop experimental module on 3 phase induction motor coil connection for vocational study. This proposed module will be applied in additional study to make understanding via practical study for making technical skills to vocational students. The simple use of experimental module was designed for 3 phase motor learning beginners. With this module, the student can see and touch coil connections of 3 phase induction motor that is not visible with real motor. The coil connections will be set by students. After connections finish, the motor can be tested to approve for each connection. The research was divided to 2 parts. The first part is design and construction of experimental module. The topic analysis was applied to classify the experimental topics. The experimental skills and practices for each analyzed topic were defined by objective analysis. The objective in each topic was to design the experimental procedures, tools, measurements and module layout by the task analysis. The second part of research is the experimental sheet whose design was based on the experimental procedures. The coils are placed on the experimental kit that shows all of coils inside the 3 phase induction motor. The connections of each coil will be connected by students who insert experimental wires to the sockets following procedures in the sheet. After finishing the wire connection, the students can test by supplying the power to the proposed experimental module to check the operation of motor. The students can understand by practice to develop skill of connection for coils in the motor from the proposed experimental module. To firstly evaluate the proposed experimental module, the study of use satisfaction test was applied to 15 second year students in vocational certificate study on electrical power program of SuratThani Polytechnic College. For the results, the students who evaluated the proposed module in 3 sides of satisfaction have scored as 4.59 or 91.8% of full scores.

Keywords: Experimental module, 3 phase induction motor, Vocational study

1.INTRODUCTION

Nowadays, Thai society changes rapidly due to advances in communication technology and computer. Teachers need to keep up to date with the technology as an academic leader. Moreover, teachers need to know how to use communication tools to think, analyze and solve problems. Schools need to support teachers in their learning new tools as well as morals so that they can work and teach as a real academic leader for the nation. Media is important because it can facilitate the communication between instructors and learners effectively. Learners can understand the contents as intended by instructors. All forms of media are important for learning. For instruction, media is often called "teaching material" and for learning, it is called "learning material". These can be radio, television, diagram and the like. The physical device can convey the message to the students well. Therefore, the researchers decided to develop one teaching material about 3 phase induction motor in order to be used as an effective way for learners to learn about coil connection in 3 phase induction motor in a short time. Another benefit might be that students see the whole picture of coil connection in 3 phase induction motor. This will be called "experimental module" on 3 phase induction motor coil connection for vocational study.

This study presents the experimental module on 3 phase induction motor coil connection which will be useful for instruction as follows:

- It will be useful for teachers in vocational colleges for their instruction.
- It will become a suggestion in terms ofpolicy for related educational institution about the directionfor the development of experimental module forthe general public.

2.CONTENT ANALYSIS

To analyze the content on motor coil connections, the topic analysis was used. By using this analysis, the content of coil connections for 3 phase motor can be divided in two parts. The first part is star connection and the second part is delta connection as shown in Fig.1. After finished the content analysis, all details of analyzed topics were used to teaching point analysis as shown in table 1.

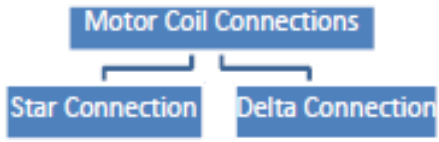

Fig. 1 Topic analysis for motor coil connections.

Table 1: Teaching point analysis.

3 phase motor coil connections	
Topics	Teaching points
1. Star Connection	1.1 Diagram reading. 1.2 Cable connection. 1.3 Circuit testing.
2. Delta Connection	2.1 Diagram reading. 2.2 Cable connection. 2.3 Circuit testing.

From the teaching point analysis results, the construction of the proposed experimental module can be yielded as shown in Fig.2.

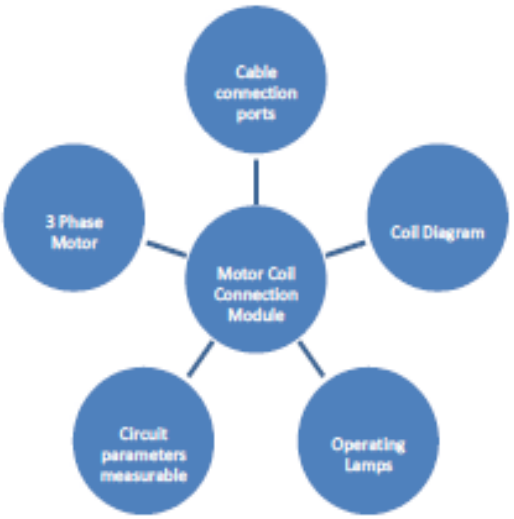

Fig. 2 Construction of proposed experimental module.

3. CONSTRUCTIONAL DESIGN

From Fig.2, the proposed module was designed by dividing to 2 parts as star connection and delta connection as shown in Fig. 3 and 4. To serve practical learning in teaching points in table 1, functions of the proposed module were considered. The module must have the connection port for student connecting the cable to make the coil connection as assigned by laboratory sheet. Next, the coil diagram of motor in each connection must be show on the module for student making understand while they practice with the module. For safety, the operating lamps must be installed on the module due to student can suggest the power supply is turning on or not. To suggest coil connected motor performance, real 3 phase motor must be installed on the module.

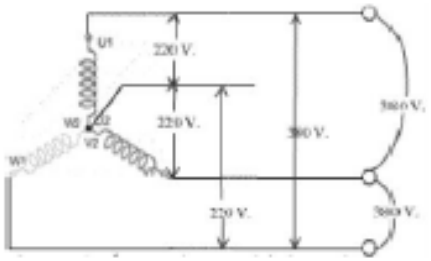

Fig. 3 Motor Coil in star connection.

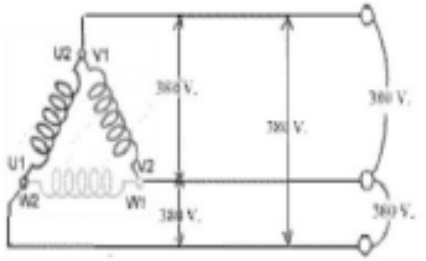

Fig. 4 Motor Coil in delta connection.

The details shown in Fig.2 were realized to the proposed module as shown in Fig.5. To control the operation of the proposed module, the control box was installed as shown in Fig.6. By simple construction of the module, the measurements can be used conveniently. For example, when the students want to measure the current in line, they can do by using clip amp as shown in Fig. 7.

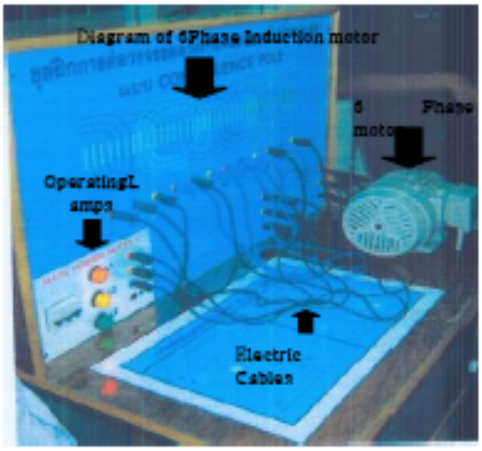

Fig. 5 Overview of the proposed module.

Fig. 6 Control box for the proposed module.

Fig. 7 Current measurement during the experiment.

4. LABORATORY SHEET DESIGN

From the teaching point analysis in Table 1, the laboratory sheets that use for student practice learning were designed as 2 sheets. Each sheet is consisted of experimental topics, objectives, experimental tools and devices, experimental circuit, experimental procedures, experimental questions, and conclusion. The experimental topics were divided in 2 topics as by using the experimental circuit in Fig. 3 and 4. The objectives shown in each laboratory sheet can be divided as 2 levels. First level is general objectives that use to indicate what laboratory wants student get understanding in general. Next level is behavior objectives that use to indicate what behavior students can show when study the proposed laboratory set in each laboratory. The experimental tools and devices were detailed what tools and devices are needed in each laboratory sheet. The experimental procedures were used to explain what students have to do while experimenting in each laboratory. The experimental circuits were shown the circuits that used in each laboratory sheet. The circuits have to show circuit schematic. The experimental questions and conclusions were used for students summarizing all experimental results in each laboratory sheet. These questions must be designed to have student behaviors following the experimental objectives.

5. EVALUATIONS

To firstly evaluate the proposed experimental module, the student of use satisfaction test was applied. It was done by 15 students from 2nd year of vocational certificate study in electrical power department, Surat Thani Polytechnic College, Surat Thani province, Thailand. The hypothesis was set at 80% of full scores. The satisfactions in 3 sides were designed. The first side of satisfaction was experimental module construction, the second side of satisfaction was experimental module design and the last side of satisfaction was experimental module use. The scores were ranged from 1-5 for each evaluated topic. The statistical analyses for the data from the test were shown in table 2. From the table, the average score were 4.59 or 91.8% of full score.

Table 2: Summary of posttest scores

Details	Level of score						
	5	4	3	2	1	$\bar{X}$	S.D.
1.Construction							
1.1Size and shape	46.70	46.70	6.70	-	-	4.40	0.63
1.2 Beauty	80.00	13.30	6.70	-	-	4.73	0.59
1.3 Durability	66.70	33.30	-	-	-	4.67	0.49
2.Design							
2.1 Mechanism	60.00	40.00	-	-	-	4.60	0.51
2.2 Installation	66.70	33.30	-	-	-	4.67	0.49
2.3 Material	86.70	13.30	-	-	-	4.87	0.35
3.Usability							
3.1 Simplicity	33.30	60.00	6.70	-	-	4.27	0.59
3.2 Understanding	66.70	26.70	6.70	-	-	4.60	0.63
3.3 Followed objective	33.30	66.70	-	-	-	4.33	0.49
3.4 Safety	73.30	26.70	-	-	-	4.73	0.46
3.5 Worth investing	66.70	33.30	-	-	-	4.67	0.49
Average						4.59	0.29

6. CONCLUSIONS

Experimental module on 3 phase induction motor coil connection for vocational study was proposed. The topic analysis was applied to define experimental content of the proposed set. After got the experimental topics, the teaching point analysis was used to define the experimental competencies of students, pattern of the set layout, and set functions. The laboratory sheets were designed for covering the set teaching points and were divided as 4 sheets. Each sheet was consisted of experimental topics, objectives, experimental tools and devices, experimental circuit, experimental procedures, experimental questions, and conclusion. To evaluate the proposed module, the satisfaction test was applied for 15

students. The scores were ranged from 1-5 for each evaluated topic. The statistical analyses for the data from the test were shown in table 2. From the table, the average score were 4.59 or 91.8% of full score.

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