

The Method for Improving the Undergraduate Ability of Electrical Specialty under the New Background of Power Industry Development

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Abstract. In order to improve the undergraduate ability of electrical specialty, this paper studies the way of training undergraduate ability by means of graduation design. In the logic order of raising problems, analyzing problems and solving problems, based on the necessary survey and broad references, the undergraduate of electrical specialty was guided to determine the research direction, put forward questions, and determine the title of the graduation design. By enlightening method to clear the relevant concepts on references, undergraduate ability of overall view was developed to analyze problem, determine the specific content and methods of the research problems, and formulate specific implementation steps. Finally, the ability to solve the problem was trained, and undergraduate was guided to set up the specific system figure and mathematical model, and complete the related calculation and result analysis. The method proposed in this paper was illustrated in detail with the example of "load forecasting method of distribution network considering the influence of wind power generation". Graduation design practices show that the method proposed in this paper can obviously improve the comprehensive ability of the undergraduates of electrical specialty.

Introduction

In recent years, great changes have taken place in power system. The distributed generation (DG) are developed rapidly, the microgrids has been created and promoted by DGs, and the race to build smart grid is on [1]. With rapid development wind power, solar power, hydropower and other renewable energy, the transformation of energy production to renewable energy is a major demand for sustainable development of energy and economy in China and the whole world [2]. Under this new development background, the power industry needs a large number of excellent talents, especially the undergraduates with certain skills. With the development of the power industry, it is urgent to improve the undergraduate ability and reserve talents for the power industry. In the teaching system of cultivating electrical undergraduate ability, it includes basic theory, professional theory, curriculum design, graduation design, experiment and practice, etc. The graduation design plays an irreplaceable role for undergraduate of electrical Specialty. It is not only the basic training for the integration of undergraduates' knowledge, but also the basic method for cultivating student creative thinking in the teaching system [3].

In order to enhance the undergraduate ability of electrical specialty based on the undergraduate graduation design and the development of power industry, this paper aims at training undergraduates' ability of asking questions, analyzing problems and solving problems, and studies the methods to enhance undergraduate ability in electrical majors.

The Method of Improving the Undergraduate Ability

Cultivation the Undergraduate Ability of Posing Questions

The ability of posing questions is the key to cultivating the creative ability of undergraduate. With the rapid development of power industry, the content of power industry is more and more extensive, such as power network planning, distributed generation optimization and control, load forecasting, smart grid, and so on[4-7]. For an undergraduate, it is not easy to put forward a specific problem. It is necessary to guide the students to do the necessary research, and read a certain amount of references. Then it is possible to determine a certain direction of research. After determining the direction of research, undergraduate can confirm the research status and trend of the research direction on the related literature, so that undergraduate can be guided to ask questions and clarify their goals. Next, undergraduate can confirm the title of graduation design.

Cultivation the Undergraduate Ability of Analyzing Problems

The cultivation of the ability of analyzing problems begins with to read the literature purposefully and define the relevant concepts. Then, from the overall view, the ability to analyze problem is trained. Undergraduate should be guided to have a comprehensive understanding of the problems studied, roughly outline the framework of implementation, identify the specific contents of the research questions, formulate specific implementation steps, and determine the methods used.

Further, the first level headings in the directory should be determined. The completion sequence of each chapter needs to be formulated and the time used is estimated. Then the undergraduate can analyze the contents of each chapter and contact between each other, and determine the second, third, and following level headlines of each chapter. The next step is to guide the students to analyze how the chapters are organized, to determine the basic contents of the chapters and the focus of the study. For the focus of research, students need to further study and analyze.

Cultivation the Undergraduate Ability of Solving Problems

After careful analysis of graduation design title, the undergraduate can be guided to solve problems concretely, establish specific system diagrams and mathematical models, confirm specific steps, and complete load forecasting. In this process, undergraduate' knowledge will be integrated, such as mathematics, computer technology, advanced programming language, basic courses, specialized courses, foreign languages, etc.

Example of Graduation Design

Preliminary Analysis Process

An undergraduate graduated in 2016 is taken as an example to illustrate the above method. The undergraduate took a month to determine the title of the graduation design, "load forecasting method of distribution network considering the influence of wind power generation". The primary task is to clarify related concepts, such as content of load forecasting [4], significance of load forecasting [8], influence factors of load forecasting[6, 9, 10], characteristics of grid-connected wind power [5], the accuracy significance of load forecasting [2], etc. The second task is to study methods of load forecasting [4, 11]. Because the grey prediction method can comprehensively reflect many factors [4], and explore the inherent rule of raw data based on data mining and processing [12], the undergraduate finally uses grey prediction to predict the load with wind power.

Simple System of Grid-connected Wind Power

The simple system of grid-connected wind power generation is shown in Figure 1.

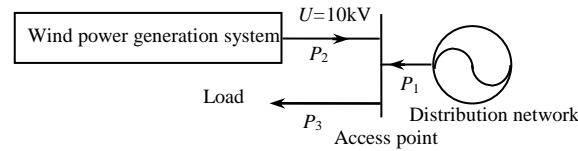


Figure 1. Simple system of grid-connected wind power

At the access point in Figure 1, the relationship of active power is as follows:

$$P_3 = P_2 + P_1 \quad (1)$$

Where, P_1 is the active power from the distribution network (MW); P_2 is the active power from wind power generation (MW); P_3 is the active power consumed by the user (MW).

Development of GM (1, n) Model

In order to predict the P_1 , the GM (1, n) model was established by the grey prediction method [13]. Assuming that there are n variables: x_1, x_2, \dots, x_n , original series formed by these variables are as follows:

$$x_i^{(0)} = [x_i^{(0)}(1), x_i^{(0)}(2), \dots, x_i^{(0)}(n)] \quad (i = 1, 2, \dots, n) \quad (2)$$

The randomness of the original data $x_i^{(0)}$ is weakened, and a new series $x_i^{(1)}$ is generated, which is:

$$\begin{aligned} x_i^{(1)} &= [x_i^{(1)}(1), x_i^{(1)}(2), \dots, x_i^{(1)}(n)] \\ &= \left[\sum_{m=1}^1 x_i^{(0)}(m), \sum_{m=1}^2 x_i^{(0)}(m), \dots, \sum_{m=1}^n x_i^{(0)}(m) \right] \quad (i = 1, 2, \dots, n) \end{aligned} \quad (3)$$

The GM (1, n) model is constructed, the first order linear differential equation of n variable, is as follows:

$$\frac{dx_1^{(1)}}{dt} + ax_1^{(1)} = b_1x_2^{(1)} + b_2x_3^{(1)} + \dots + b_{n-1}x_n^{(1)} \quad (4)$$

The parameter \hat{a} of the above equation is listed as:

$$\hat{a} = (a, b_1, b_2, \dots, b_{n-1})^T \quad (5)$$

The parameter \hat{a} is solved by the following formula:

$$\hat{a} = (B^T B)^{-1} B^T Y_n \quad (6)$$

$$B = \begin{bmatrix} -\frac{1}{2}[x_1^{(1)}(1) + x_1^{(1)}(2)] & x_2^{(1)}(2) & \dots & x_n^{(1)}(2) \\ -\frac{1}{2}[x_1^{(1)}(2) + x_1^{(1)}(3)] & x_2^{(1)}(3) & \dots & x_n^{(1)}(3) \\ \dots & \dots & \dots & \dots \\ -\frac{1}{2}[x_1^{(1)}(n-1) + x_1^{(1)}(n)] & x_2^{(1)}(n) & \dots & x_n^{(1)}(n) \end{bmatrix} \quad (7)$$

$$Y_n = \begin{bmatrix} x_1^{(0)}(2) \\ x_1^{(0)}(3) \\ \dots \\ x_1^{(0)}(n) \end{bmatrix} \quad (8)$$

After obtaining the unique solution of the parameter \hat{a} , the prediction equation of n variables is obtained, as follows:

$$\hat{x}_1^{(1)}(k+1) = \left[x_1^{(0)}(1) - \frac{1}{a} \sum_{i=2}^n b_{i-1} x_i^1(k+1) \right] e^{-ak} + \frac{1}{a} \sum_{i=2}^n b_{i-1} x_i^1(k+1) \quad (9)$$

The prediction model of $x_1^{(0)}$ can be obtained by the reduction subtraction calculation, as follows:

$$\hat{x}_1^{(0)}(k+1) = \hat{x}_1^{(1)}(k+1) - \hat{x}_1^{(1)}(k) \quad (10)$$

Load Forecasting Based on Grey Prediction Model

Considering the influence of wind power generation P_2 , the GM (1, n) model is used to predict the of distribution network power P_1 in Figure 1. The P_1 is the original series $x_1^{(0)}$, and the original number of the P_2 is the original series $x_2^{(0)}$, and the specific data of is $x_1^{(0)}$ and $x_2^{(0)}$ shown in Table 1.

Table 1. Historical data on power distribution and wind power

Number	1	2	3	4	5
Date	May 10th	May 11th	May 12th	May 13th	May 14th
$x_1^{(0)}(k)$ [MW]	5.36	5.49	5.35	5.65	5.27
$x_2^{(0)}(k)$ [MW]	0.14	0.15	0.13	0.16	0.14

Using formula (2)-(10), the parameters a and b have been calculated, $a=2.005$, $b=75.736$. The following differential equation has been listed as follows:

$$\frac{dx_1^{(1)}}{dt} + 2.005x_1^{(1)} = 75.736x_2^{(1)} \quad (11)$$

The prediction equation established by the formula (9) is as follows:

$$\hat{x}_1^{(1)}(k+1) = \left[5.36 - 37.78x_2^{(1)}(k+1) \right] e^{-2.005k} + 37.78x_2^{(1)}(k+1) \quad (12)$$

The prediction model of $x_1^{(1)}$ has been tested. The predictive value $x_1^{(0)}$ by the formula (10) has been calculated, as shown in Figure 2. And the reduction test has been completed, as shown in Figure 3.

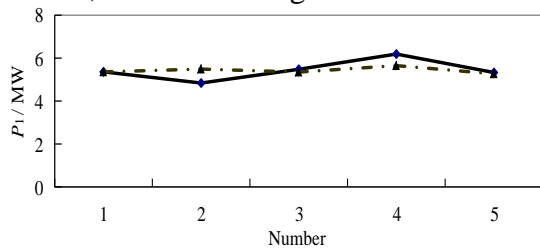


Figure 2. Prediction curve of distribution network power P_1

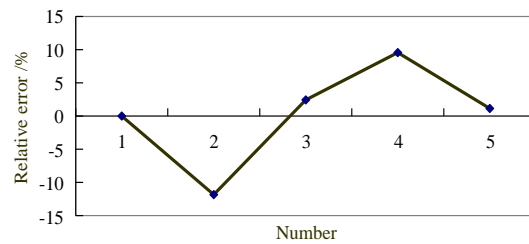


Figure 3. Relative error curve

In Figure 2, the solid line is a prediction curve, and the dotted line is the actual power curve. Compared with the actual power value, the reduction test is completed, and the relative error curve is shown in Figure 3. The average relative error is 0.258%, and the maximum relative error is -11.84%. Using the grey prediction model, the distribution network power P_1 has been predicted on May 15, 2015, and the specific value is as follows:

$$\hat{x}_1^{(0)}(6) = \hat{x}_1^{(1)}(6) - \hat{x}_1^{(1)}(5) = 32.11 - 27.20 = 4.91 \text{ MW}$$

The actual power $x_1^{(0)}(6)$ is 5.04 MW on May 15, 2015. The relative error between the forecast value and the actual value is 2.58%.

Conclusion

With the rapid development of the power industry, a large number of outstanding undergraduates of electrical specialty are needed, and the undergraduate ability is becoming more and more important.

The graduation design can be used to integrate electrical specialty students' knowledge together. In the graduation design, the undergraduates can be guided to establish corresponding mathematical models, compile corresponding programs or establish simulation models, solve problems and analyze the results. Therefore, undergraduates are trained to raise questions, analyze and solve problems, and to further cultivate the creative thinking of undergraduate. It is important that the creative thinking of undergraduates has been trained.

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