The Teaching Content Reform for Information and Communication Engineering Graduate Degree Course “Broadband Mobile Communication Networks” Based on Knowledge System Construction

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Abstract. “Broadband Mobile Communication Networks” is a graduate degree course of information and communication engineering major in a large numbers of universities. But there are some problems about this course such as old teaching content and without constructing knowledge system. In order to solve these problems, we take the enhancement of broadband mobile communication network performance and capacity as the goal, construct the knowledge system and redesign the teaching content. After implementation, good teaching results have been achieved.

1. Introduction

In Sep. 2014, China’s Ministry of Education issued “The Opinions on Improving and Strengthening the Construction of Graduate Courses” [1], in which proposed that “Take the education objectives and degree requirements as the fundamental basis for course system design. Fully implement the graduate training objectives and degree requirements of the discipline and attach importance to system design and overall optimization of the course system.” Broadband Mobile Communication Networks (BMCN), as a degree course of information/electronics and communication engineering major in many universities, plays a decisive role in the graduate students’ knowledge system construction. Therefore, in order to satisfy the graduate students’ demand about BMCN knowledge and the new trend of the communication industry, it is necessary to systematically design and optimize the teaching content.

2. Problems in the Current Course System

The current reference textbooks [2] for the "Broadband Mobile Communication Network" course are:

- Chapter 1—Overview of Broadband Mobile Communication Networks: It mainly introduces the development history, system evolution, characteristics, research status and challenges of broadband mobile communication networks.
- Chapter 2—Physical layer transmission technology of broadband mobile communication network: It mainly introduces the main technical progress of wireless communication in recent years, including: adaptive code modulation technology, multiple access technology, orthogonal frequency division multiplexing technology, multi-antenna technology cooperative diversity technology.
- Chapter 3—MAC Layer Protocol of Broadband Mobile Communication Network: It mainly introduces WLAN MAC layer protocol, Ad Hoc MAC layer protocol and WiMax MAC layer protocol.
- Chapter 4—Mobile IP and Routing Algorithms for Broadband Mobile Communication Networks: It mainly introduces mobile IP technology and several routing algorithms involved in wireless communication.
Chapter 5—Wireless Sensor Network: It mainly introduces the characteristics, architecture, topology, protocol stack and related standards of wireless sensor networks. Through the understanding of the technical development trends of the industry and the accumulation of teaching experience in previous years, we can find the following problems in the above teaching contents:

1. Non-technical content takes up too much class time, and the teaching effect is not good: A total of 32 class hours are scheduled for this course. Most of the contents of the first chapter and the contents of the fourth chapter and the fifth chapter (development history, characteristics, etc.) take up about 10 class hours. The number of class hours spent is close to one-third of the total hours of the course.

2. The physical layer transmission technology introduced in Chapter 2 is not the latest achievement in the field of broadband mobile communication. It also does not explain the connection between these technologies and broadband mobile communication networks and the use of these technologies in broadband mobile communication what problems are solved in the network.

3. The third chapter simply lists the MAC layer protocols of the three wireless communication networks. Firstly, the protocol is relatively old. Secondly, it did not distinguish between the primary and secondary, and introduced the three protocols in a more general way. It did not form a technical system with the transmission technology introduced in Chapter 2.

4. Chapter 4 lists the routing algorithms. It does not indicate the usage scenarios of these routing algorithms in broadband mobile communication networks and what benefits can be brought about by using these routing algorithms.

5. The wireless sensor network introduced in Chapter 5 is basically not in the category of broadband mobile communication networks. It is obviously unreasonable to design these teaching contents in this course.

In order to solve the above problems, it is necessary to systematically arrange the teaching content of the "Broadband Mobile Communication Network" course to construct the knowledge system of this course.

3. The Principle of Teaching Content Reform Based on Knowledge System Construction

   Based on the characteristics of this course [3, 4], the construction of the overall knowledge system of graduate students, the selection of postgraduate research topics and the employment direction of graduate students, the reform of teaching content based on constant knowledge system needs to obey the following principles:

   • The goal of the teaching content should be definitude: the technology involved in the course should aim at improving the performance and capacity of the broadband mobile communication network;
   • The content of the course should be novel: The reformed teaching content must be the new wireless communication technology that has emerged in recent years, so that students have mastered the technological development trend of the industry;
   • The content of the course should be systemized: the content of each teaching unit after the reform should not only have different emphasis, but also must have necessary links to build knowledge system that aims to improve system performance and capacity.

4. Course Knowledge System Construction and Teaching Content Design

   The original intention of the reform of the course teaching content and the construction of the knowledge system is to improve the capacity of the broadband mobile communication network. In order to improve the system capacity of the broadband mobile communication network, the new wireless communication technology involved is shown in Figure 1. According to the relationship between various wireless communication technologies and improving the capacity of the broadband mobile communication system in Figure 1, the knowledge system of this course is designed as shown in Figure 2. The dotted line box indicates the new broadband wireless communication
technology described in the course. When designing the teaching links, these new technologies are the content. While introducing the technical principles, we pay attention to the role played by these technologies in improving the performance of broadband mobile communication systems.

$$C_{\text{sum}} \leftrightarrow \sum_{\text{Cells}} \sum_{\text{Channels}} B \log_2 \left( 1 + \frac{P_j}{I_j + N_j} \right)$$

Figure 1. The New Wireless Communication Technology in Broadband Mobile Communication Networks.

Figure 2. The Knowledge System of Graduate Course “Broadband Mobile Communication Networks”.
According to Figure 1 and Figure 2, we designed the teaching content and the class hour arrangement as shown in Table 1 (32 class hours in total).

TABLE I. Teaching Content and the Class Hour Arrangement.

| Teaching Content                                                                 | Number of Class Hours |
|----------------------------------------------------------------------------------|-----------------------|
| overview and knowledge system introduction                                      | 2                     |
| coverage enhancement technology-ultra dense heterogeneous network                | 2                     |
| coverage enhancement technology-D2D                                              | 2                     |
| coverage enhancement technology-M2M                                              | 2                     |
| frequency efficiency upgrading technology- massive MIMO                          | 2                     |
| frequency efficiency upgrading technology- FBMC                                  | 2                     |
| frequency efficiency upgrading technology- spatial modulation                    | 2                     |
| Spectrum Expansion Technology- Cognitive Radio                                    | 2                     |
| Spectrum Expansion Technology- Millimeter Wave                                   | 2                     |
| Spectrum Expansion Technology- Visible Light                                     | 2                     |
| energy efficiency upgrading technology- green communication                      | 2                     |
| energy efficiency upgrading technology- interference management                  | 2                     |
| non orthogonal multiple access                                                   | 2                     |
| user scheduling and resource allocation                                          | 2                     |
| user/network cooperation                                                         | 2                     |
| simulation practice and discussion                                               | 4                     |

5. Implementation Effect

After the reform of the course content, the 2016 level information and communication engineering/electronics and communication engineering graduate students will be taught as a pilot. According to the anonymous evaluation information of students, the number of students selected in this course is 19, of which 16 people rated A (excellent) as 84.2% for the teaching effect of the course; 3 persons with the evaluation of B (good) accounted for 15.8%. Students are generally more satisfied with the content of the course. In terms of details, the most satisfying aspect of the students is the novelty of knowledge, followed by the complete knowledge system; the most dissatisfied place is the lack of practice and discussion, which is one of the directions of the next step of the teaching reform in this course.

6. Conclusions

In this paper, we make a reform of the teaching content of the graduate degree course of information and communication engineering major – “Broadband Mobile Communication Networks” based on knowledge system construction. We take the broadband wireless communication system capacity upgrading as the goal and introduce a larger number of new wireless communication technologies as the teaching content. After one-year implementation of the course, the teaching effectiveness is better than before.

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