

MINISTRY OF EDUCATION AND TRAINING  
**QUY NHON UNIVERSITY**

**DOCTORAL PROGRAM**

|                |                                  |
|----------------|----------------------------------|
| Level:         | <b>Doctoral</b>                  |
| Major:         | <b>Algebra and number theory</b> |
| Code:          | <b>9460104</b>                   |
| Mode of study: | <b>Full-time</b>                 |

*Binh Dinh, 2023*

## DOCTORAL PROGRAM

*(Issued together with Decision No. 2019/QĐ-ĐHQN dated July 31, 2023  
of the Rector of Quy Nhon University)*

|                |                                  |
|----------------|----------------------------------|
| Level:         | <b>Doctoral</b>                  |
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| Code:          | <b>9460104</b>                   |
| Mode of study: | <b>Full-time</b>                 |

### 1. PROGRAM OBJECTIVES (POs)

#### 1.1. General objectives

This program aims to train doctoral students who possess political qualities, ethics, professional responsibility, and a sense of service to the people; possess fundamental, core, advanced, in-depth, and applied theoretical knowledge in the field of Mathematics in general and the specialty of Algebra and Number Theory in particular; possess research skills and a comprehensive perspective on mathematical issues; possess the capacity for independent and creative research, the development of new knowledge, and the ability to detect and resolve emerging practical problems; possess the capacity to propose and organize scientific and technological research, and provide professional leadership in the field of Algebra and Number Theory; effectively meet the requirements in teaching, scientific research, and professional management, fulfilling the demand for high-quality human resources to serve scientific research, national development, and international integration.

The program aims to equip learners with fundamental knowledge and a deep understanding of Mathematics in general and the specialty of Algebra and Number Theory in particular. At the same time, it equips learners with the skills to research and perceive mathematical issues comprehensively, thereby enabling the capacity for self-directed research, solving practical problems, and effectively meeting the requirements in teaching, scientific research, and professional management at educational institutions, colleges, universities, and research institutes.

#### 1.2. Specific objectives

The program trains doctoral students in Algebra and Number Theory gained the following knowledge, skills, and qualities:

- **PO1:** Demonstrate solid knowledge of political science, along with strong political qualities, ethical standards, professional responsibility, and a commitment to serving the community.

- **PO2:** Possess fundamental, core, and foundational knowledge, as well as modern, advanced, in-depth, and applied theories in Mathematics in general and the specialty of Algebra and Number Theory in particular.

- **PO3:** Possess knowledge of organizational governance and the management of professional activities in the research and development of Mathematics in general and Algebra and Number Theory in particular.

- **PO4:** Master scientific theories, methods, and tools to conduct research and develop new knowledge in Mathematics, specifically in Algebra and Number Theory; possess skills in analytical reasoning and synthesis to creatively solve practical problems related to the field.

- **PO5:** Possess skills in critical thinking, analysis, and synthesis, with the capacity for self-directed in-depth research to acquire new knowledge; possess problem-posing and problem-solving skills; commit to lifelong learning and research.

- **PO6:** Demonstrate the ability to work independently and in teams; possess skills in professional management and leadership of research groups in Algebra and Number Theory; participate in discussions, disseminate research results, and supervise scientific research within the specialty.

- **PO7:** Maintain self-awareness and a clear understanding of the role and importance of self-study and independent literature review to pose and solve problems; continuously enhance professional qualifications through lifelong learning and research.

- **PO8:** Uphold professional ethics, taking individual and collective responsibility; demonstrate responsibility toward the community, society, the profession, and the environment.

## **2. JOB OPPORTUNITIES AND PROFESSIONAL DEVELOPMENT**

Graduates of the Doctoral program in Algebra and Number Theory will be capable of:

- **Teaching** at universities and colleges nationwide;
- **Serving as professional managers** at educational and training institutions, as well as educational management agencies;
- **Working as mathematical researchers** at research institutes, specialized mathematical centers, universities, and colleges;
- **Pursuing further studies** in post-doctoral training programs (Post-doc).

## **3. LEARNING OUTCOMES (PLOs)**

The program is designed to ensure that doctoral graduates achieve the following learning outcomes:

- **PLO1:** Understand and apply political science knowledge and fundamental, core mathematical principles to professional activities and daily life.

- **PLO2:** Evaluate modern, advanced, and specialized theories in Algebra and Number Theory, and assess the applicability of Mathematics in general, and Algebra and Number Theory in particular, to other scientific and technological fields.

- **PLO3:** Analyze scientific issues within the specialty of Algebra and Number Theory and provide expert-level situational solutions.

- **PLO4:** Apply core, foundational, and advanced theoretical knowledge to manage, organize, and operate professional activities in teaching, scientific research, and practical applications of Algebra and Number Theory.

- **PLO5:** Master and apply skills in critical thinking, analysis, synthesis, and evaluation of data and information using scientific methods; demonstrate effective teamwork to achieve common goals.

- **PLO6:** Proficiently apply scientific theories, methods, and tools to conduct research and development in the field of Algebra and Number Theory.

- **PLO7:** Update, synthesize, and analyze scientific issues; flexibly utilize research works to solve problems creatively and uniquely within the field of Algebra and Number Theory and address practical challenges.

- **PLO8:** Organize and manage professional activities and research groups in Algebra and Number Theory; participate in discussions, consultations, policy critiques, and the publication of research results; proficiently and creatively disseminate mathematical knowledge.

- **PLO9:** Apply expertise in Algebra and Number Theory to generate new ideas and knowledge in diverse contexts; provide self-direction and leadership in research and teaching; manage research projects with high responsibility for professional development; engage in academic exchange with domestic and international research groups (demonstrating English proficiency equivalent to the CEFR B2 level and utilizing computing tools to support research).

- **PLO10:** Self-orient and adapt to changing research environments; formulate professional conclusions and defend personal academic perspectives.

#### **4. ADMISSION REQUIREMENTS**

- Candidates must have graduated with a Master's degree or a specialized Level 7 training program in a relevant major; or have graduated with Honors (High Distinction) at the Bachelor's level (or equivalent and higher) in a relevant major; and must demonstrate research capacity and experience.

- Candidates must possess a foreign language proficiency of at least Level 4 according to the 6-level Foreign Language Proficiency Framework for Vietnam (or an equivalent level or higher).

+ Candidates with a Master's degree in a relevant major:

| No | Doctoral Major            | Master's degree requirements                                | Note                                                          |
|----|---------------------------|-------------------------------------------------------------|---------------------------------------------------------------|
| 1  | Algebra and number theory | Algebra and number theory (8460104)                         | <b>Category 1:</b> No supplementary courses required          |
|    |                           | Applied mathematics (8460112)                               |                                                               |
|    |                           | Theory of Probability and Mathematical Statistics (8460106) |                                                               |
|    |                           | Mathematical analysis (8460104)                             |                                                               |
|    |                           | Geometry and topology (8460105)                             |                                                               |
|    |                           | Mathematical Foundations for Computer Science (8460110)     | <b>Category 2:</b> Supplementary courses required (4 credits) |
|    |                           | Methods for elementary mathematics (8460113)                |                                                               |
|    |                           | Data science (8904648)                                      |                                                               |

**Note:** The supplementary courses for Category 2 candidates will be determined by the Scientific Council of the Faculty of Mathematics and Statistics for each individual candidate, based on the recommendations of the Supervisors. These courses are selected from the Elective sections of the List of Supplementary Courses or from the Doctoral-level courses.

+ Candidates with a Bachelor's degree (Honors/High Distinction) in a relevant major who are required to take supplementary courses:

| No | Doctoral Major            | Bachelor's degree majors (Honors/High Distinction) requiring supplementary knowledge                                                                                                                                                                      | Supplementary courses                                                                                                                                                                           | Note              |
|----|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1  | Algebra and number theory | - Education in Mathematics (7140209)<br>- Mathematics (7460101)<br>- Applied Mathematics (7460112)<br>- Mechanical Mathematics (7460115)<br>- Mathematics and Computer Science (7460117)<br>- Computational Science (7460107)<br>- Data science (7460108) | <b>+Fundamental Knowledge: 16 credits</b><br>- Compulsory: 10 credits<br>- Elective: 6 credits<br><b>+Specialized knowledge: 14 credits</b><br>- Compulsory: 8 credits<br>- Elective: 6 credits | <b>Category 3</b> |

## 5. ADMISSION TARGETS

According to the current admission regulations of the Ministry of Education and Training and Quy Nhon University. Specifically, this includes Categories 1, 2, and 3 as specified in Section 4.

## 6. PROGRAM DURATION AND TOTAL ACADEMIC WORKLOAD

**6.1. Program duration:** From 03 years (36 months) to 04 years (48 months)

**6.2. Total academic workload:**

| <b>Program structure</b>                                                                                                             | <b>Credits</b> |
|--------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>I. Supplementary courses</b>                                                                                                      | <b>30</b>      |
| <b>Fundamental knowledge</b>                                                                                                         | <b>16</b>      |
| Compulsory courses                                                                                                                   | 10             |
| Elective courses                                                                                                                     | 6              |
| <b>Specialized courses</b>                                                                                                           | <b>14</b>      |
| Compulsory courses                                                                                                                   | 4              |
| Elective courses                                                                                                                     | 10             |
| <b>II. Doctoral-level courses (including compulsory courses, elective courses, doctoral topics, and the literature review essay)</b> | <b>15</b>      |
| <b>Doctoral-level courses</b>                                                                                                        | <b>9</b>       |
| Compulsory courses                                                                                                                   | 3              |
| Elective courses                                                                                                                     | 6              |
| <b>Doctoral topics</b>                                                                                                               | <b>4</b>       |
| Topic 1                                                                                                                              | 2              |
| Topic 2                                                                                                                              | 2              |
| <b>Literature review essay</b>                                                                                                       | <b>2</b>       |
| <b>III. Scientific research and doctoral thesis</b>                                                                                  | <b>75</b>      |
| Scientific research                                                                                                                  | 15             |
| Doctoral thesis                                                                                                                      | 60             |
| <b>Total</b>                                                                                                                         |                |
| <b>PhD Candidates with a Master's Degree (Category 1)</b>                                                                            | <b>90</b>      |
| <b>PhD Candidates with a Master's Degree (Category 2)</b>                                                                            | <b>94</b>      |
| <b>PhD Candidates with a Bachelor's Degree (Category 3)</b>                                                                          | <b>120</b>     |

## 7. TRAINING METHOD, GRADUATION REQUIREMENTS

### 7.1. Training method

Training under the credit system is regulated by the Training Regulations of the Ministry of Education and Training and of Quy Nhon University.

### 7.2. Graduation requirements

Doctoral students shall be considered for graduation recognition and the awarding of a doctoral degree upon fulfilling the following requirements:

- a) The doctoral student's dissertation has been officially approved and passed by the University-level Doctoral Dissertation Evaluation Council;
- b) The doctoral student has submitted both printed and digital copies of the finalized dissertation to the University. This version must include the candidate's signature, the

certification of the supervisory team, and the confirmation from the Chairman of the Evaluation Council verifying that all required revisions and supplements (if any) have been completed;

c) The doctoral student has submitted both digital and printed copies of the dissertation abstract and the complete final dissertation to the National Library of Vietnam. These documents must bear the signature of the candidate, the signatures of the supervisors, and the official certification from the University.

## 8. ASSESSMENT METHODS, GRADING SCALE

### 8.1. Grading scale

A 10-point grading scale is used for all assessment components of the course.

### 8.2. Format, evaluation criteria, and scoring system

Implementation shall follow the current Regulations on Enrollment and Doctoral Training issued by the Ministry of Education and Training (MOET) and Quy Nhon University (QNU). Specific evaluation criteria are detailed within the syllabus of each individual course.

### 8.3. Assessment methods

Implementation shall follow the current Regulations on Enrollment and Doctoral Training issued by the Ministry of Education and Training (MOET) and Quy Nhon University (QNU). Specific evaluation criteria are detailed within the syllabus of each individual course.

## 9. PROGRAM CONTENT

| No                        | Course code |         | Course name         | Year | No. of credits |             |       |                          | Prerequisite Course Code | Department/Faculty in charge             | Note |
|---------------------------|-------------|---------|---------------------|------|----------------|-------------|-------|--------------------------|--------------------------|------------------------------------------|------|
|                           | Letters     | Numbers |                     |      | Total          | Theoretical | Tests | Experimental / Practical |                          |                                          |      |
| I. Supplementary courses  |             |         |                     |      | 30             |             |       |                          |                          |                                          |      |
| I.1 Fundamental knowledge |             |         |                     |      | 16             |             |       |                          |                          |                                          |      |
| Compulsory courses        |             |         |                     |      | 10             |             |       |                          |                          |                                          |      |
| 1                         | CSBB        | 502     | Topological theory  | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 2                         | CSBB        | 503     | Functional analysis | 1    | 3              |             |       |                          | CSB B 502                | Department of Mathematics and Statistics | 1    |

| No                                         | Course code |         | Course name              | Year | No. of credits |             |       |                          | Prerequisite Course Code | Department/Faculty in charge             | Note |
|--------------------------------------------|-------------|---------|--------------------------|------|----------------|-------------|-------|--------------------------|--------------------------|------------------------------------------|------|
|                                            | Letters     | Numbers |                          |      | Total          | Theoretical | Tests | Experimental / Practical |                          |                                          |      |
| 3                                          | CSBB        | 505     | Algebra 1                | 1    | 3              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 4                                          | CSBB        | 506     | Algebra 2                | 1    | 2              |             |       |                          | CSBB 505                 | Department of Mathematics and Statistics | 1    |
| <b>Elective courses (select 2 courses)</b> |             |         |                          |      | <b>6</b>       |             |       |                          |                          |                                          |      |
| 5                                          | ĐSTC        | 501     | Theory of Groebner basis | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 6                                          | ĐSTC        | 502     | Homological algebra      | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 7                                          | ĐSTC        | 503     | Group cohomology         | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 8                                          | ĐSTC        | 504     | Theory of fields         | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 9                                          | ĐSTC        | 505     | Commutative algebra      | 1    | 2              |             |       |                          | CSBB 506                 | Department of Mathematics and Statistics | 1    |
| <b>I.2 Specialized knowledge</b>           |             |         |                          |      | <b>14</b>      |             |       |                          |                          |                                          |      |
| <b>Compulsory courses</b>                  |             |         |                          |      | <b>4</b>       |             |       |                          |                          |                                          |      |
| 1                                          | ĐSBB        | 501     | Group theory             | 1    | 2              |             |       |                          | CSBB 506                 | Department of Mathematics                | 1    |

| No                                         | Course code |         | Course name                 | Year | No. of credits |             |       |                          | Prerequisite Course Code | Department/Faculty in charge             | Note |
|--------------------------------------------|-------------|---------|-----------------------------|------|----------------|-------------|-------|--------------------------|--------------------------|------------------------------------------|------|
|                                            | Letters     | Numbers |                             |      | Total          | Theoretical | Tests | Experimental / Practical |                          |                                          |      |
|                                            |             |         |                             |      |                |             |       |                          |                          | s and Statistics                         |      |
| 2                                          | DSBB        | 502     | Theory of rings and modules |      |                |             |       |                          | CSB B 506, DSBB 508      | Department of Mathematics and Statistics | 1    |
| <b>Elective courses (select 5 courses)</b> |             |         |                             |      | <b>10</b>      |             |       |                          |                          |                                          |      |
| 3                                          | DSTC        | 506     | Category theory             | 1    | 2              |             |       |                          | DSB B 511                | Department of Mathematics and Statistics | 1    |
| 4                                          | DSTC        | 507     | Matric computation          | 1    | 2              |             |       |                          | CSB B 506                | Department of Mathematics and Statistics | 1    |
| 5                                          | DSTC        | 508     | Number theory               | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 6                                          | DSTC        | 509     | Group representation theory | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 7                                          | DSTC        | 510     | Differential Galois theory  | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 8                                          | DSTC        | 511     | Arithmetic geometry         | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 9                                          | DSTC        | 512     | Lattice theory              | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |

| No                                                      | Course code |         | Course name                        | Year | No. of credits |             |       |                          | Prerequisite Course Code | Department/Faculty in charge             | Note |
|---------------------------------------------------------|-------------|---------|------------------------------------|------|----------------|-------------|-------|--------------------------|--------------------------|------------------------------------------|------|
|                                                         | Letters     | Numbers |                                    |      | Total          | Theoretical | Tests | Experimental / Practical |                          |                                          |      |
| 10                                                      | ĐSTC        | 513     | Singularity theory                 | 1    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| <b>II. Doctoral-level courses</b>                       |             |         |                                    |      | <b>15</b>      |             |       |                          |                          |                                          |      |
| <b>II.1. Compulsory courses</b>                         |             |         |                                    |      | <b>3</b>       |             |       |                          |                          |                                          |      |
| 1                                                       | ĐSBB        | 801     | Advanced algebra                   | 2    | 3              |             |       |                          | CSB B 506                | Department of Mathematics and Statistics | 1    |
| <b>II.2. Elective courses (<i>select 2 courses</i>)</b> |             |         |                                    |      | <b>6</b>       |             |       |                          |                          |                                          |      |
| 2                                                       | ĐSTC        | 801     | Differential topology              | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 3                                                       | ĐSTC        | 802     | Theory of p-groups                 | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 4                                                       | ĐSTC        | 803     | Singular homology and cohomology   | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 5                                                       | ĐSTC        | 804     | Real algebraic geometry            | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 6                                                       | ĐSTC        | 805     | Matrix analysis                    | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 7                                                       | ĐSTC        | 806     | Matrix theory on commutative rings | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics |      |

| No                                                   | Course code |         | Course name                                             | Year | No. of credits |             |       |                          | Prerequisite Course Code | Department/Faculty in charge             | Note |
|------------------------------------------------------|-------------|---------|---------------------------------------------------------|------|----------------|-------------|-------|--------------------------|--------------------------|------------------------------------------|------|
|                                                      | Letters     | Numbers |                                                         |      | Total          | Theoretical | Tests | Experimental / Practical |                          |                                          |      |
| 8                                                    | ĐSTC        | 807     | Computer algebra                                        | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 9                                                    | ĐSTC        | 808     | Algebraic geometry                                      | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 10                                                   | ĐSTC        | 809     | Matrix computation                                      | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| 11                                                   | ĐSTC        | 810     | Algebraic curves                                        | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| 12                                                   | ĐSTC        | 811     | Quantum information theory                              | 2    | 3              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| <b>III. Doctoral topics (<i>select 2 topics</i>)</b> |             |         |                                                         |      | <b>4</b>       |             |       |                          |                          |                                          |      |
| 1                                                    | ĐSCĐ        | 801     | Local deformation theory                                | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 2                                                    | ĐSCĐ        | 802     | Equinormalizable deformations of isolated singularities | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 3                                                    | ĐSCĐ        | 803     | Modular invariant theory                                | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 4                                                    | ĐSCĐ        | 804     | Cohomological operators                                 | 3    | 2              |             |       |                          |                          | Department of                            | 1    |

| No | Course code |         | Course name                                                    | Year | No. of credits |             |       |                          | Prerequisite Course Code | Department/Faculty in charge             | Note |
|----|-------------|---------|----------------------------------------------------------------|------|----------------|-------------|-------|--------------------------|--------------------------|------------------------------------------|------|
|    | Letters     | Numbers |                                                                |      | Total          | Theoretical | Tests | Experimental / Practical |                          |                                          |      |
|    |             |         |                                                                |      |                |             |       |                          |                          | Mathematics and Statistics               |      |
| 5  | ĐSCĐ        | 805     | Some Positivstellensatz and moment problems                    | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 6  | ĐSCĐ        | 806     | Positivstellensatz and applications in polynomial optimization | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 7  | ĐSCĐ        | 807     | Intersection theory                                            | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| 8  | ĐSCĐ        | 808     | Moduli spaces                                                  | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| 9  | ĐSCĐ        | 809     | Elimination theory for differential algebras                   | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 10 | ĐSCĐ        | 810     | Some inequalities involving operator means                     | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 11 | ĐSCĐ        | 811     | Equinormalizable deformations of isolated singularities        | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 12 | ĐSCĐ        | 812     | Equisingular theory for curve singularities                    | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |

| No | Course code |         | Course name                                                  | Year | No. of credits |             |       |                          | Prerequisite Course Code | Department/Faculty in charge             | Note |
|----|-------------|---------|--------------------------------------------------------------|------|----------------|-------------|-------|--------------------------|--------------------------|------------------------------------------|------|
|    | Letters     | Numbers |                                                              |      | Total          | Theoretical | Tests | Experimental / Practical |                          |                                          |      |
| 13 | ĐSCĐ        | 813     | QF rings and simple injective rings                          | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 14 | ĐSCĐ        | 814     | Category $\sigma[M]$                                         | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 15 | ĐSCĐ        | 815     | Commutative algebra                                          | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 16 | ĐSCĐ        | 816     | Linear preserving problems for matrices on commutative rings | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| 17 | ĐSCĐ        | 817     | Pseudospectra of matrix polynomials                          | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| 18 | ĐSCĐ        | 818     | Schubert calculus                                            | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| 19 | ĐSCĐ        | 819     | Some invariants of algebraic varieties                       | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| 20 | ĐSCĐ        | 820     | Some problems on simultaneous decomposition of matrices      | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics | 1    |
| 21 | ĐSCĐ        | 821     | Theory of one variable function fields                       | 3    | 2              |             |       |                          |                          | Department of Mathematics                |      |

| No                                                          | Course code |         | Course name                               | Year | No. of credits |             |       |                          | Prerequisite Course Code | Department/Faculty in charge             | Note |
|-------------------------------------------------------------|-------------|---------|-------------------------------------------|------|----------------|-------------|-------|--------------------------|--------------------------|------------------------------------------|------|
|                                                             | Letters     | Numbers |                                           |      | Total          | Theoretical | Tests | Experimental / Practical |                          |                                          |      |
|                                                             |             |         |                                           |      |                |             |       |                          |                          | s and Statistics                         |      |
| 22                                                          | ĐSCĐ        | 822     | Some quantum distance and and divergences | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| 23                                                          | ĐSCĐ        | 823     | Quantum fidelities                        | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| 24                                                          | ĐSTL        | 801     | Literature review essay                   | 3    | 2              |             |       |                          |                          | Department of Mathematics and Statistics |      |
| <b>IV. Scientific research and doctoral thesis</b>          |             |         |                                           |      | <b>75</b>      |             |       |                          |                          |                                          |      |
| <b>Total</b>                                                |             |         |                                           |      |                |             |       |                          |                          |                                          |      |
| <b>PhD Candidates with a Master's Degree (Category 1)</b>   |             |         |                                           |      | <b>90</b>      |             |       |                          |                          |                                          |      |
| <b>PhD Candidates with a Master's Degree (Category 2)</b>   |             |         |                                           |      | <b>94</b>      |             |       |                          |                          |                                          |      |
| <b>PhD Candidates with a Bachelor's Degree (Category 3)</b> |             |         |                                           |      | <b>120</b>     |             |       |                          |                          |                                          |      |

## 10. TENTATIVE TEACHING PLAN

| No                        | Course code           | Course name         | No. of credits | Tentative teaching plan<br><i>(year)</i> |   |   |   | Proposed lecturers                                |
|---------------------------|-----------------------|---------------------|----------------|------------------------------------------|---|---|---|---------------------------------------------------|
|                           |                       |                     |                | 1                                        | 2 | 3 | 4 |                                                   |
| I. Supplementary courses  |                       |                     |                |                                          |   |   |   |                                                   |
| I.1                       | Fundamental knowledge |                     |                |                                          |   |   |   |                                                   |
| <i>Compulsory courses</i> |                       |                     |                |                                          |   |   |   |                                                   |
| 1                         | CSBB 502              | Topological theory  | 2              | x                                        |   |   |   | Huỳnh Minh Hiền<br>Lương Đăng Kỳ<br>Mai Thành Tấn |
| 2                         | CSBB 503              | Functional analysis | 3              | x                                        |   |   |   | Thái Thuần Quang<br>Nguyễn Văn Đại                |

| No                                         | Course code                  | Course name                 | No. of credits | Tentative teaching plan<br>(year) |   |   |   | Proposed lecturers                   |
|--------------------------------------------|------------------------------|-----------------------------|----------------|-----------------------------------|---|---|---|--------------------------------------|
|                                            |                              |                             |                | 1                                 | 2 | 3 | 4 |                                      |
| 3                                          | CSBB 505                     | Algebra 1                   | 3              | x                                 |   |   |   | Lê Thanh Hiếu<br>Lê Công Trình       |
| 3                                          | CSBB 506                     | Algebra 2                   | 2              | x                                 |   |   |   | Phạm Thùy Hương<br>Nguyễn Bìn        |
| <b>Elective courses</b>                    |                              |                             |                |                                   |   |   |   |                                      |
| 5                                          | ĐSTC 501                     | Theory of Groebner basis    | 2              | x                                 |   |   |   | Ngô Lâm Xuân Châu<br>Nguyễn Bìn      |
| 6                                          | ĐSTC 502                     | Homological algebra         | 2              | x                                 |   |   |   | Trần Đình Lương                      |
| 7                                          | ĐSTC 503                     | Group cohomology            | 2              | x                                 |   |   |   | Trần Đình Lương<br>Lê Minh Hà        |
| 8                                          | ĐSTC 504                     | Theory of fields            | 2              | x                                 |   |   |   | Lê Thanh Hiếu<br>Ngô Lâm Xuân Châu   |
| 9                                          | ĐSTC 505                     | Commutaitve algebra         | 2              | x                                 |   |   |   | Phạm Thùy Hương<br>Lê Công Trình     |
| I.2                                        | <b>Specialized knowledge</b> |                             |                |                                   |   |   |   |                                      |
| <b>Compulsory courses</b>                  |                              |                             |                |                                   |   |   |   |                                      |
| 1                                          | ĐSBB 501                     | Group theory                | 2              | x                                 |   |   |   | Trần Đình Lương<br>Phạm Thùy Hương   |
| 2                                          | ĐSBB 502                     | Theory of rings and modules | 2              | x                                 |   |   |   | Lê Thanh Hiếu<br>Lê Công Trình       |
| <b>Elective courses (select 5 courses)</b> |                              |                             |                |                                   |   |   |   |                                      |
| 3                                          | ĐSTC 506                     | Category theory             | 2              | x                                 |   |   |   | Trần Đình Lương<br>Phạm Thùy Hương   |
| 4                                          | ĐSTC 507                     | Matrix computation          | 2              | x                                 |   |   |   | Lê Thanh Hiếu<br>Lê Công Trình       |
| 5                                          | ĐSTC 508                     | Number theory               | 2              | x                                 |   |   |   | Nguyễn Bìn<br>Trần Đình Lương        |
| 6                                          | ĐSTC 509                     | Group representation theory | 2              | x                                 |   |   |   | Trần Đình Lương<br>Ngô lâm Xuân Châu |
| 7                                          | ĐSTC 510                     | Differential Galois theory  | 2              | x                                 |   |   |   | Ngô Lâm Xuân Châu<br>Lê Công Trình   |

| No                                | Course code | Course name                             | No. of credits | Tentative teaching plan<br>(year) |   |   |   | Proposed lecturers                             |
|-----------------------------------|-------------|-----------------------------------------|----------------|-----------------------------------|---|---|---|------------------------------------------------|
|                                   |             |                                         |                | 1                                 | 2 | 3 | 4 |                                                |
| 8                                 | ĐSTC 511    | Arithmetic geometry                     | 2              | x                                 |   |   |   | Trần Đình Lương<br>Ngô Lâm Xuân Châu           |
| 9                                 | ĐSTC 512    | Lattice theory                          | 2              | x                                 |   |   |   | Lê Công trình<br>Ngô Lâm Xuân Châu             |
| 10                                | ĐSTC 513    | Singularity theory                      | 2              | x                                 |   |   |   | Phạm Thùy Hương<br>Lê Công Trình               |
| <b>II. Doctoral-level courses</b> |             |                                         |                |                                   |   |   |   |                                                |
| <i>II.1. Compulsory courses</i>   |             |                                         |                |                                   |   |   |   |                                                |
| 1                                 | ĐSBB 801    | Advanced algebra                        | 3              |                                   | x |   |   | Lê Công Trình<br>Phạm Thùy Hương               |
| <i>II.2. Elective courses</i>     |             |                                         |                |                                   |   |   |   |                                                |
| 2                                 | ĐSTC 801    | Differential topology                   | 3              |                                   | x |   |   | Ngô Lâm Xuân Châu<br>Nguyễn Sum                |
| 3                                 | ĐSTC 802    | Theory of p-groups                      | 3              |                                   | x |   |   | Trần Đình Lương<br>Nguyễn Sum                  |
| 4                                 | ĐSTC 803    | Singular homology and cohomology        | 3              |                                   | x |   |   | Trần Đình Lương<br>Lê Công Trình               |
| 5                                 | ĐSTC 804    | Real algebraic geometry                 | 3              |                                   | x |   |   | Lê Công Trình<br>Lê Thanh Hiếu                 |
| 6                                 | ĐSTC 805    | Matrix analysis                         | 3              |                                   | x |   |   | Lê Thanh Hiếu<br>Lê Công Trình                 |
| 7                                 | ĐSTC 806    | Theory of matrices on commutative rings | 3              |                                   | x |   |   | Lê Công Trình<br>Lê Thanh Hiếu                 |
| 8                                 | ĐSTC 807    | Computer algebra                        | 3              |                                   | x |   |   | Ngô Lâm Xuân Châu<br>Lê Thanh Hiếu             |
| 9                                 | ĐSTC 808    | Algebraic geometry                      | 3              |                                   | x |   |   | Phạm Thùy Hương<br>Nguyễn Bin<br>Lê Công Trình |
| 10                                | ĐSTC 809    | Matrix computation                      | 3              |                                   | x |   |   | Lê Thanh Hiếu<br>Lê Công Trình                 |
| 11                                | ĐSTC 810    | Algebraic curves                        | 3              |                                   | x |   |   | Nguyễn Bin<br>Phạm Thùy Hương                  |

| No                          | Course code | Course name                                                     | No. of credits | Tentative teaching plan<br>(year) |   |   |   | Proposed lecturers                 |
|-----------------------------|-------------|-----------------------------------------------------------------|----------------|-----------------------------------|---|---|---|------------------------------------|
|                             |             |                                                                 |                | 1                                 | 2 | 3 | 4 |                                    |
|                             |             |                                                                 |                |                                   |   |   |   | Lê Công Trình                      |
| 12                          | ĐSTC 811    | Quantum information theory                                      | 3              |                                   | x |   |   | Lê Công Trình                      |
| <b>III. Doctoral topics</b> |             |                                                                 |                |                                   |   |   |   |                                    |
| 1                           | ĐSCĐ 801    | Local deformation theory                                        | 2              |                                   |   | x |   | Lê Công Trình<br>Phạm Thuỳ Hương   |
| 2                           | ĐSCĐ 802    | On equinormalizable deformations                                | 2              |                                   |   | x |   | Lê Công Trình<br>Phạm Thuỳ Hương   |
| 3                           | ĐSCĐ 803    | Modular invariant theory                                        | 2              |                                   |   | x |   | Trần Đình Lương<br>Nguyễn Sum      |
| 4                           | ĐSCĐ 804    | Cohomological operators                                         | 2              |                                   |   | x |   | Trần Đình Lương<br>Nguyễn Sum      |
| 5                           | ĐSCĐ 805    | Some Positivstellensätze and moment problems                    | 2              |                                   |   | x |   | Lê Công Trình<br>Lê Thanh Hiếu     |
| 6                           | ĐSCĐ 806    | Positivstellensätze and applications in polynomial optimization | 2              |                                   |   | x |   | Lê Công Trình<br>Lê Thanh Hiếu     |
| 7                           | ĐSCĐ 807    | Intersection theory                                             | 2              |                                   |   | x |   | Đặng Tuấn Hiệp<br>Phạm Thuỳ Hương  |
| 8                           | ĐSCĐ 808    | Moduli spaces                                                   | 2              |                                   |   | x |   | Đặng Tuấn Hiệp<br>Phạm Thuỳ Hương  |
| 9                           | ĐSCĐ 809    | Elimination theory for differential algebra                     | 2              |                                   |   | x |   | Ngô Lâm Xuân Châu<br>Lê Công Trình |
| 10                          | ĐSCĐ 810    | Some inequalities involving operator means                      | 2              |                                   |   | x |   | Lê Công Trình<br>Lê Thanh Hiếu     |
| 11                          | ĐSCĐ 811    | Equinormalizable deformations for isolated singularities        | 2              |                                   |   | x |   | Lê Công Trình<br>Phạm Thuỳ Hương   |

| No                                                  | Course code | Course name                                             | No. of credits | Tentative teaching plan<br>(year) |          |          |          | Proposed lecturers                             |
|-----------------------------------------------------|-------------|---------------------------------------------------------|----------------|-----------------------------------|----------|----------|----------|------------------------------------------------|
|                                                     |             |                                                         |                | 1                                 | 2        | 3        | 4        |                                                |
| 12                                                  | ĐSCĐ 812    | Equisingular deformations for curve singularities       | 2              |                                   |          | x        |          | Lê Công Trình<br>Phạm Thuỳ Hương               |
| 13                                                  | ĐSCĐ 813    | QF rings and simple injective rings                     | 2              |                                   |          | x        |          | Trần Đình Lương<br>Phạm Thuỳ Hương             |
| 14                                                  | ĐSCĐ 814    | sigma[M] category                                       | 2              |                                   |          | x        |          | Trần Đình Lương<br>Phạm Thuỳ Hương             |
| 15                                                  | ĐSCĐ 815    | Commutative algebra                                     | 2              |                                   |          | x        |          | Phạm Thuỳ Hương<br>Nguyễn Bin<br>Lê Công Trình |
| 16                                                  | ĐSCĐ 816    | Linear preserving problems on commutative rings         | 2              |                                   |          | x        |          | Lê Công Trình<br>Lê Thanh Hiếu                 |
| 17                                                  | ĐSCĐ 817    | Pseudospectra of matrix polynomials                     | 2              |                                   |          | x        |          | Lê Công Trình<br>Lê Thanh Hiếu                 |
| 18                                                  | ĐSCĐ 818    | Schubert calculus                                       | 2              |                                   |          | x        |          | Đặng Tuấn Hiệp<br>Lê Công Trình                |
| 19                                                  | ĐSCĐ 819    | Some invariants of algebraic varieties                  | 2              |                                   |          | x        |          | Đặng Tuấn Hiệp<br>Lê Công Trình                |
| 20                                                  | ĐSCĐ 820    | Some problems on simultaneous decomposition of matrices | 2              |                                   |          | x        |          | Đặng Tuấn Hiệp<br>Lê Công Trình                |
| 21                                                  | ĐSCĐ 821    | Theory of one variable algebraic functional fields      | 2              |                                   |          | x        |          | Ngô Lâm Xuân Châu<br>Phạm Thuỳ Hương           |
| 22                                                  | ĐSCĐ 822    | Some distance functions and quantum divergences         | 2              |                                   |          | x        |          | Lê Công Trình<br>Lê Thanh Hiếu                 |
| 23                                                  | ĐSCĐ 823    | Quantum fidelities                                      | 2              |                                   |          | x        |          | Lê Công Trình<br>Lê Thanh Hiếu                 |
| 24                                                  | ĐSTL 801    | Literature review essay                                 | 2              |                                   |          | x        |          | Supervisors                                    |
| <b>III. Scientific research and doctoral thesis</b> |             |                                                         | <b>75</b>      |                                   |          |          |          |                                                |
| <b>Scientific research</b>                          |             |                                                         | <b>15</b>      | <b>x</b>                          | <b>x</b> | <b>x</b> | <b>x</b> | <b>Supervisors</b>                             |

| No              | Course code | Course name | No. of credits | Tentative teaching plan<br><i>(year)</i> |   |   |   | Proposed lecturers |
|-----------------|-------------|-------------|----------------|------------------------------------------|---|---|---|--------------------|
|                 |             |             |                | 1                                        | 2 | 3 | 4 |                    |
| Doctoral thesis |             |             | 60             |                                          |   |   | x | Supervisors        |

*Binh Dinh, July 31, 2023*

**BY THE DELEGATION  
OF THE RECTOR  
VICE-RECTOR**

**DEAN OF FACULTY**

**HEAD OF GRADUATE  
OFFICE**

**Assoc. Prof. Dr.  
Le Cong Trinh**

**Assoc. Prof. Dr.  
Ho Xuan Quang**

**Dr. Dinh Anh Tuan**