SOUTH DAKOTA BOARD OF REGENTS

Academic and Student Affairs
Consent

AGENDA ITEM: 5 – B (3)
DATE: December 11-12, 2024

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SUBJECT

New Program Request – SDSMT – Minor in Quantum Information Science

CONTROLLING STATUTE, RULE, OR POLICY

BOR Policy 2.3.2 – New Programs, Program Modifications, and Inactivation/Termination

BACKGROUND / DISCUSSION

South Dakota School of Mines & Technology (SDSMT) requests authorization to offer a minor in Quantum Information Science. The proposed minor is one of two quantum computing minors being proposed collaboratively by SDSMT and Dakota State University (DSU). These programs leverage the complementary strengths of both universities, SDSMT's focus on engineering and sciences of quantum materials and DSU's focus on expertise in cybersecurity and cryptography.

The proposed minor will provide foundational knowledge in quantum computing, quantum communications, quantum sensing and their applications. This knowledge will allow traditionally trained scientists and engineers to more readily integrate with quantum technology industry and apply their engineering and science training.

IMPACT AND RECOMMENDATION

SDSMT plans to offer the minor in Quantum Information Science on campus and at DSU. SDSMT does not request new state resources. No new courses will be required. SDSMT estimates 20 students enrolled and 10 graduates by the fourth year of the program.

Board office staff recommends approval.

ATTACHMENTS

Attachment I – New Program Request Summary: SDSMT – Minor in Quantum Information Science

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DRAFT MOTION 20241211_5-B(3):

I move to authorize SDSMT to offer a minor in Quantum Information Science, as presented.

SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

New Baccalaureate Degree Minor

Use this form to propose a new baccalaureate degree minor (the minor may include existing and/or new courses. An academic minor within a degree program enables a student to make an inquiry into a discipline or field of study beyond the major or to investigate a particular content theme. Minors provide a broad introduction to a subject and therefore develop only limited competency. Minors consist of a specific set of objectives achieved through a series of courses. Course offerings occur in a specific department or may draw from several departments (as in the case of a topical or thematic focus). In some cases, all coursework within a minor proscribed; in others cases, a few courses may form the basis for a wide range of choices. Regental undergraduate minors typically consist of 18 credit hours. Proposals to establish new minors as well as proposals to modify existing minors must recognize and address this limit. The Board of Regents, Executive Director, and/or their designees may request additional information about the proposal. After the university President approves the proposal, submit a signed copy to the Executive Director through the system Chief Academic Officer. Only post the New Baccalaureate Degree Minor Form to the university website for review by other universities after approval by the Executive Director and Chief Academic Officer.

UNIVERSITY:	SDSM&T
TITLE OF PROPOSED MINOR:	**Quantum Information Science**
DEGREE(S) IN WHICH MINOR MAY BE EARNED:	**BS Engineering and Science Majors**
EXISTING RELATED MAJORS OR MINORS:	**None**
INTENDED DATE OF IMPLEMENTATION:	**Fall 2025**
PROPOSED CIP CODE:	**15.1601**
UNIVERSITY DEPARTMENT:	**Nanoscience & Biomedical Engineering**
BANNER DEPARTMENT CODE:	**MNNS**
UNIVERSITY DIVISION:	**Science & Letters**
BANNER DIVISION CODE:	**4L**

☒ **Please check this box to confirm that:**

- The individual preparing this request has read AAC Guideline 2.3.2.2.D, which pertains to new baccalaureate degree minor requests, and that this request meets the requirements outlined in the guidelines.
- This request will not be posted to the university website for review of the Academic Affairs Committee until it is approved by the Executive Director and Chief Academic Officer.

University Approval

To the Board of Regents and the Executive Director: I certify that I have read this proposal, that I believe it to be accurate, and that it has been evaluated and approved as provided by university policy.

President of the University	Click here to enter a date. Date

Note: In the responses below, references to external sources, including data sources, should be documented with a footnote (including web addresses where applicable).

1. Do you have a major in this field (*place an "X" in the appropriate box*)? ☐ *Yes* ☒ *No*

2. If you do not have a major in this field, explain how the proposed minor relates to your university mission and strategic plan, and to the current Board of Regents Strategic Plan 2014-2020.

Links to the applicable State statute, Board Policy, and the Board of Regents Strategic Plan are listed below for each campus.

BHSU:	*SDCL § 13-59*	*BOR Policy 1.2.1*
DSU:	*SDCL § 13-59*	*BOR Policy 1.2.2*
NSU:	*SDCL § 13-59*	*BOR Policy 1.2.3*
SDSMT:	*SDCL § 13-60*	*BOR Policy 1.2.4*
SDSU:	*SDCL § 13-58*	*BOR Policy 1.2.5*
USD:	*SDCL § 13-57*	*BOR Policy 1.2.6*

Board of Regents Strategic Plan

South Dakota Mines does not currently have a major in quantum information science (QIS) as this is an emerging area of engineering and science. This minor is responsive to Pillar 1 of South Dakota Mines' mission, as South Dakota Mines has developed relationships with the quantum communications company Qubitekk and quantum computing leader Intel Corporation and these industry leaders are seeking engineers with QIS training. Pillar 1 of South Dakota Mines' strategic plan states: "Academic and co-curricular excellence, objective 1.1: Offer distinctive academic programs that are responsive to industry needs and prepare graduates to solve global challenges …", thus the proposed minor in QIS is responsive to South Dakota Mines' strategic plan. Similarly, the minor is responsive to the Board of Regents Strategic Plan goals 3 and 4, "Academic Excellence, Student Success and Educational Attainment", and "Workforce and Economic Development" by offering state-of-the-art education responsive to industry and by providing these needed workforce skills.

The collaborative minors in Quantum Computing for Cybersecurity at Dakota State University (DSU) and Quantum Information Science at South Dakota Mines (SDM) exemplify a strategic partnership that drives innovation and supports both the South Dakota Board of Regents' (SDBOR) and South Dakota School of Mines and Technology's strategic plans. These programs leverage complementary strengths of both universities: SDM's focus on engineering and science of quantum materials and DSU's expertise in cybersecurity and cryptography, addressing critical needs for workforce development, economic growth, and academic excellence in the state. The partnership directly aligns with the SDBOR Strategic Plan Goal 4, by creating academic programs that respond to the future demands of the workforce, ensuring South Dakota remains competitive in the knowledge economy. As quantum computing reshapes fields like cybersecurity and artificial intelligence, these minors prepare students to address complex technological challenges, contributing to regional workforce development and positioning the state at the forefront of technological innovation. The efficient use of faculty expertise and shared resources between the two institutions aligns with Goal 1, promoting responsible governance and minimizing program duplication across the university system.

3. What is the nature/purpose of the proposed minor? Please include a brief (1-2 sentence) description of the academic field in this program.

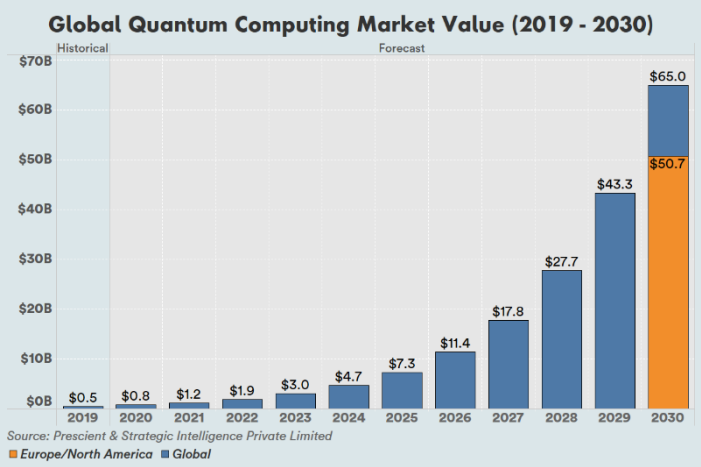
The minor provides foundational knowledge in quantum computing, quantum communications, quantum sensing and their applications. This knowledge will allow traditionally trained scientists and engineers to more readily integrate with quantum technology industry and apply their engineering and science training.

4. How will the proposed minor benefit students?

The minor in QIS will provide engineering and science students at the BS level with basic knowledge of quantum information science, leveraging their traditional engineering and science degrees to prepare them for careers in a burgeoning quantum information industry.

5. Describe the workforce demand for graduates in related fields, including national demand and demand within South Dakota. *Provide data and examples; data sources may include but are not limited to the South Dakota Department of Labor, the US Bureau of Labor Statistics, Regental system dashboards, etc. Please cite any sources in a footnote.*

The market for quantum computing is predicted to grow 20-fold by 2030[1]. We will provide qualified students to work in this burgeoning industry. The National Quantum initiative supports workforce development through multiple programs including NSF's Q-AMASE-i program which funds the MonArk Quantum Foundry and the newly funded Quantum Materials Institute in which Nanoscience and Nanoengineering faculty are partners[2] and the progenitors[3], and the Regional Innovation Engine "Northern Plains Applied Quantum CORE" which has been recommended for funding[4]. These activities present new opportunities for our students to enter an NSF defined "Industry of the Future".



6. Provide estimated enrollments and completions in the table below and explain the methodology used in developing the estimates (*replace "XX" in the table with the appropriate year*).

	Fiscal Years*			
	1st	2nd	3rd	4th
Estimates	FY 26	FY 27	FY 28	FY 29
Students enrolled in the minor (fall)	**5**	**10**	**15**	**20**

[1] Qubitekk quantum cryptography industry leader, https://qubitekk.com
[2] https://www.monarkfoundry.org
[3] https://www.sdsmt.edu/news/releases/quantummaterialsinstitute.html
[4] https://beta.nsf.gov/funding/initiatives/regional-innovation-engines

Completions by graduates	**0**	**0**	**5**	**10**

*Do not include current fiscal year.

7. What is the rationale for the curriculum? Demonstrate/provide evidence that the curriculum is consistent with current national standards.

The rationale for the curriculum is to leverage traditional engineering and science degrees by providing a route for specialized training in quantum computing, quantum communications and quantum sensing (collectively QIS) industries, so our graduates can participate in QIS research and development now emerging in industry. Our curriculum can be compared to the Quantum Engineering minor offered by Colorado School of Mines, which is nationally recognized.

8. Complete the tables below. Explain any exceptions to Board policy requested.
Minors by design are limited in the number of credit hours required for completion. Minors typically consist of eighteen (18) credit hours, including prerequisite courses. In addition, minors typically involve existing courses. If the curriculum consists of more than eighteen (18) credit hours (including prerequisites) or new courses, please provide explanation and justification below.

A. Distribution of Credit Hours

[Insert title of proposed minor]	**Credit Hours**	**Percent**
Requirements in minor	8	44%
Electives in minor	10	56%
Total	18	

B. Required Courses in the Minor

Prefix	**Number**	**Course Title** *2 of 3 required*	**Prerequisites for Course**	**Credit Hours**	**New (yes, no)**
NANO	406/406L	Introduction to Quantum Computing and Applications	CSC170/170L[5]	4	No
NANO	405/405L	Quantum Photonics and Communications		4	No
			Subtotal	8	

9. Elective Courses in the Minor: List courses available as electives in the program. Indicate any proposed new courses added specifically for the minor.

[5] CSC 170/170L is applicable to almost all bachelor degrees at SDM, so the overwhelming majority of students will have this pre-requisite completed.

Prefix	Number	Course Title *(add or delete rows as needed)*	Prerequisites for Course *Include credits for prerequisites in subtotal below.*	Credit Hours *Choose 11 -12 Cr. Hr.*	New (yes, no)
MATH/CSC	251	Finite Structures		3	No
CENG	244/244L	Digital Signal Processing		3	No
MATH	315	Linear Algebra		3	No
NANO	402	Quantum Materials	EE 362 (3)	6	No
NANO	404	Nanophotonics		3	No
MATH	436 (437)	Number Theory and (Quantum)[6] Cryptography	(DSU)	3	No
EE	453/453L	Feedback Controls		4	No
CSC	448	Machine Learning		3	No
PHY	449	Computational Physics	PHYS 331 (3)	7	No
PHY	471	Quantum Mechanics		4	No
EE	362	Electronic, Magnetic, & Optical Properties of Materials		3	No
PHYS	331	Modern Physics		3	No
				10	

Catalog Note: No more than six credits from this minor may overlap with the specific required credits of a student's declared major.

A. What are the learning outcomes expected for all students who complete the minor? How will students achieve these outcomes? *Complete the table below to list specific learning outcomes—knowledge and competencies—for courses in the proposed program in each row. Label each column heading with a course prefix and number. Indicate required courses with an asterisk (*). Indicate with an X in the corresponding table cell for any student outcomes that will be met by the courses included. All students should acquire the program knowledge and competencies regardless of the electives selected. Modify the table as necessary to provide the requested information for the proposed program.*

	Program Courses that Address the Outcomes					
Individual Student Outcome (Same as in the text of the proposal)	NANO 402	NANO 404	NANO 405*	NANO 406*	PHYS 471	PHYS 449
Demonstrate knowledge of QIS principles			X	X		
Demonstrate knowledge of optics and photonics		X	X			
Demonstrate knowledge of quantum communications			X	X		
Demonstrate knowledge of quantum phenomena	X		X	X	X	
Demonstrate knowledge of computational physics				X		X

Modify the table as necessary to include all student outcomes. Outcomes in this table are to be the same ones identified in the text.

10. What instructional approaches and technologies will instructors use to teach courses in the minor? *This refers to the instructional technologies and approaches used to teach courses and NOT the technology applications and approaches expected of students.*

[6] MA 437 is the proposed number for the updated MA 436 (inserting "Quantum" in the title).

The courses are primarily face-to-face lectures and hands-on labs, some lectures may also be offered over DDN.

11. Delivery Location

Note: The accreditation requirements of the Higher Learning Commission (HLC) require Board approval for a university to offer programs off-campus and through distance delivery.

On campus: South Dakota School of Mines and Technology, Distance: Dakota State University.

A. Complete the following charts to indicate if the university seeks authorization to deliver the entire program on campus, at any off campus location (e.g., USD Community Center for Sioux Falls, Black Hills State University-Rapid City, Capital City Campus, etc.) or deliver the entire program through distance technology (e.g., as an online program)?

	Yes/No	***Intended Start Date***
On campus	Yes	**Fall 2025**

	Yes/No	***If Yes, list location(s)***	***Intended Start Date***
Off campus	Yes	DSU	**Fall 2025**

	Yes/No	***If Yes, identify delivery methods*** *Delivery methods are defined in AAC Guideline 2.4.3.B.*	***Intended Start Date***
Distance Delivery (online/other distance delivery methods)	Yes	DDN	**Fall 2025**
Does another BOR institution already have authorization to offer the program online?	No	**If yes, identify institutions:**	

B. Complete the following chart to indicate if the university seeks authorization to deliver more than 50% but less than 100% of the minor through distance learning (e.g., as an online program)? *This question responds to HLC definitions for distance delivery.*

	Yes/No	***If Yes, identify delivery methods***	***Intended Start Date***
Distance Delivery (online/other distance delivery methods)	Choose an item.		Choose an item. Choose an item.

12. Does the University request any exceptions to any Board policy for this minor? Explain any requests for exceptions to Board Policy. *If not requesting any exceptions, enter "None."*

None.

13. **Cost, Budget, and Resources: Explain the amount and source(s) of any one-time and continuing investments in personnel, professional development, release time, time redirected from other assignments, instructional technology & software, other operations and maintenance, facilities, etc., needed to implement the proposed minor.** *Address off-campus or distance delivery separately.*

    All courses are currently offered and there would be no additional costs.

14. **New Course Approval: New courses required to implement the new minor may receive approval in conjunction with program approval or receive approval separately. Please check the appropriate statement (*place an "X" in the appropriate box*).**

    ☐ YES,
    the university is seeking approval of new courses related to the proposed program in conjunction with program approval. All New Course Request forms are included as Appendix C and match those described in section 7.

    ☒ NO,
    the university is not seeking approval of all new courses related to the proposed program in conjunction with program approval; the institution will submit new course approval requests separately or at a later date in accordance with Academic Affairs Guidelines.

15. **Additional Information:** *Additional information is optional. Use this space to provide pertinent information not requested above. Limit the number and length of additional attachments. Identify all attachments with capital letters. Letters of support are not necessary and are rarely included with Board materials. The University may include responses to questions from the Board or the Executive Director as appendices to the original proposal where applicable. Delete this item if not used.*