SOUTH DAKOTA BOARD OF REGENTS

Academic and Student Affairs
Consent

AGENDA ITEM: 5 – C (1)
DATE: December 13-14, 2023

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SUBJECT

New Undergraduate and Graduate Certificate Request – SDSMT – Quantum Communications

CONTROLLING STATUTE, RULE, OR POLICY

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

BACKGROUND / DISCUSSION

South Dakota School of Mines and Technology (SDSMT) requests authorization to offer both an undergraduate and graduate certificate in Quantum Communications. The proposed certificates will provide foundational knowledge to undergraduate and graduate engineering and science students to prepare them to work in the quantum computing and communications industry. SDSMT is partnering with academic and industrial partners in quantum information and telecommunications research and industry partners to prepare engineering to enter this growing industry.

IMPACT AND RECOMMENDATION

SDSMT plans to offer the proposed certificate on campus. SDSMT does not request new state resources. Two new courses will be required.

Board office staff recommends approval.

ATTACHMENTS

Attachment I – New Certificate Request Form: SDSMT – Quantum Communications

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DRAFT MOTION_20231213_5-C(1):

I move to authorize SDSMT to offer undergraduate and graduate certificates in Quantum Communications, as presented.

SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

New Certificate

Use this form to propose a certificate program at either the undergraduate or graduate level. A certificate program is a sequence, pattern, or group of academic credit courses that focus upon an area of specialized knowledge or information and develop a specific skill set. Certificate programs typically are a subset of the curriculum offered in degree programs, include previously approved courses, and involve 9-12 credit hours including prerequisites. In some cases, standards for licensure will state explicit requirements leading to certificate programs requiring more than 12 credit hours (in such cases, exceptions to course or credit requirements must be justified and approved). 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 Certificate 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 CERTIFICATE:	**Quantum Communications**
INTENDED DATE OF IMPLEMENTATION:	**Fall 2024**
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 2.7, which pertains to new certificate 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.

	Click here to enter a date.
Institutional Approval Signature *President or Chief Academic Officer of the University*	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. **Is this a graduate-level certificate or undergraduate-level certificate (*place an "X" in the appropriate box*)?**

Undergraduate Certificate ☒ Graduate Certificate ☒

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

The certificates will provide foundational knowledge to engineering and science BS and MS students to prepare them to work in the quantum computing and communications industry. We are partnering with academic and industrial partners in quantum information and telecommunications research and industry partners to prepare engineers to enter this growing industry.

3. **If you do not have a major in this field, explain how the proposed certificate 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.

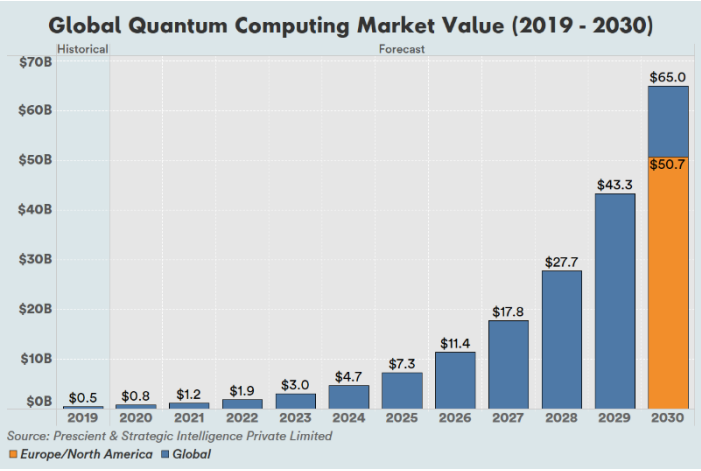
BHSU:	*SDCL § 13-59*	*BOR Policy 1:10:4*
DSU:	*SDCL § 13-59*	*BOR Policy 1:10:5*
NSU:	*SDCL § 13-59*	*BOR Policy 1:10:6*
SDSMT:	*SDCL § 13-60*	*BOR Policy 1:10:3*
SDSU:	*SDCL § 13-58*	*BOR Policy 1:10:2*
USD:	*SDCL § 13-57*	*BOR Policy 1:10:1*

Board of Regents Strategic Plan 2014-2020

We have an MS in Nanoscience and Nanoengineering, which is a broader field that encompasses the proposed certificate area.

4. **Provide a justification for the certificate program, including the potential benefits to students and potential workforce demand for those who graduate with the credential.**

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 in which Nanoscience and Nanoengineering faculty are partners[2], and the Regional Innovation Engine "Northern Plains Applied Quantum CORE" which has been recommended for funding[3]. These activities present new opportunities for South Dakota School of Mines and Technology students to



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

enter an NSF defined "Industry of the Future".

5. **Who is the intended audience for the certificate program (including but not limited to the majors/degree programs from which students are expected)?**

We expect students primarily from nanoscience, electrical engineering and physics at both the undergraduate and graduate levels.

6. **Certificate Design**
   A. **Is the certificate designed as a stand-alone education credential option for students not seeking additional credentials (i.e., a bachelor's or master's degree)? If so, what areas of high workforce demand or specialized body of knowledge will be addressed through this certificate?**

No. This certificate would prepare students to enter the workforce based on the BS or MS level engineering skills obtained and qualify them to enter the quantum information industry.

   B. **Is the certificate a value added credential that supplements a student's major field of study? If so, list the majors/programs from which students would most benefit from adding the certificate.**

Yes, BS and MS students in Nanoscience and Nanoengineering, Electrical Engineering and Physics would have the additional knowledge and credentials to enter this industry.

   C. **Is the certificate a stackable credential with credits that apply to a higher level credential (i.e., associate, bachelor's, or master's degree)? If so, indicate the program(s) to which the certificate stacks and the number of credits from the certificate that can be applied to the program.**

Yes, all credits would apply to the MS in Nanoscience and Nanoengineering, and the BS and MS degrees in electrical engineering and physics.

7. **List the courses required for completion of the certificate in the table below (if any new courses are proposed for the certificate, please attach the new course requests to this form).** *Certificate programs by design are limited in the number of credit hours required for completion. Certificate programs consist of nine (9) to twelve (12) credit hours, including prerequisite courses. In addition, certificates typically involve existing courses. If the curriculum consists of more than twelve (12) credit hours (including prerequisites) or includes new courses, please provide explanation and justification below.*

Prefix	Number	Course Title	Prerequisites for Course	Credit Hours	New (yes, no)
NANO	404/504	Nanophotonics	None	3	No
NANO	405/405L 505/505L	Quantum Photonics and Communications	NANO 404/504	(3-1) 4	Yes
NANO	406/406L 506/506L	Introduction to Quantum Computing and Applications	None	(3-1) 4	Yes
			Subtotal	11	

Explanation: The courses for the certificate program are an extension of existing areas present within or adjacent to the current NANO MS/PhD curriculum. However, new courses 405/505 and 406/506 are required to implement the focus area of the certificate program at both the BS and MS levels. NANO 404/504 is a pre-requisite for NANO 405/505 but required for the certificate so total credits required is 11.

8. Student Outcome and Demonstration of Individual Achievement.
Board Policy 2:23 requires certificate programs to "have specifically defined student learning outcomes.

A. What specific knowledge and competencies, including technology competencies, will all students demonstrate before graduation? *The knowledge and competencies should be specific to the program and not routinely expected of all university graduates.*

Students would gain a broad understanding of quantum computing and communications. They would gain industry relevant technical knowledge of photonics and telecommunications systems.

B. 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 404/504	NANO 405/505(L)	NANO 406/506(L)
Demonstrate knowledge of principles of photonics	X		
Demonstrate knowledge of quantum encrypted communication networks and their components		X	
Demonstrate knowledge of quantum algorithms and principles of quantum computation			X
Demonstrate knowledge of fiber optics	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.

Students obtaining the certificate would demonstrate knowledge of photonics and optoelectronics used in quantum encrypted networks, including a detailed understanding of single photon sources and detectors, electro-optic modulators and fiber optic communications networks used for quantum encrypted networks. Students will obtain a broad understanding of the principles behind the nascent quantum computing field and obtain practical knowledge to utilize state of the art cloud accessible quantum computers.

9. 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.

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 College 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 on-line program)?

	Yes/No	*Intended Start Date*
On campus	Yes	**Fall 2024**

	Yes/No	*If Yes, list location(s)*	*Intended Start Date*
Off campus	No		Choose an item. Choose an item.

	Yes/No	*If Yes, identify delivery methods* *Delivery methods are defined in AAC Guideline 5.5.*	*Intended Start Date*
Distance Delivery (online/other distance delivery methods)	No		Choose an item. Choose an item.
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 certificate through distance learning (e.g., as an on-line 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)	No		Choose an item. Choose an item.

10. 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.*

Nanoscience and Nanoengineering faculty are actively involved in an NSF funded quantum information science and engineering center focused on quantum materials and technologies, and a participant in the recently recommended NSF funded Regional Innovation Engines "Northern Plains Applied Quantum CORE". Nanoscience and Nanoengineering faculty are partnering with quantum communication industry leader Qubitekk to roll out this new program, in support of a growing quantum and photonics industry and in concert with the National Quantum Initiative, which aims to support the Nation's leadership in the development of quantum computing and quantum encryption technologies.