INDIAN INSTITUTE OF TECHNOLOGY MANDI

KAMAND, DISTT. MANDI – 175075 (HIMACHAL PRADESH)

Indian
Institute of
Technology
Mandi

MINUTES OF 58TH BOARD OF ACADEMICS MEETING

VENUE	:	GUEST HOUSE (NC)CONFERENCE ROOM + ONLINE
DATE	:	8th April, 2025 (TUESDAY)
TIME	:	04:30 PM

Following members attended the meeting

1.	Dean Academics	Prof. Aniruddha Chakraborty
2.	Associate Dean (Courses)	Dr. P Anil Kishan
3.	Chairman Senate Library Committee	Prof. Anjan Kumar Swain
4.	Nominee-1: School of Computing and Electrical Engineering	Dr. Padmanabhan Rajan
5.	Nominee-1: School of Civil and Environmental Engineering	Dr. Sandip Kumar Saha
6.	Nominee-2: School of Civil and Environmental Engineering	Dr. Vivek Gupta
7.	Nominee-1: School of Mechanical and Materials Engineering	Dr. Gaurav Bhutani
8.	Nominee-2: School of Mechanical and Materials Engineering	Dr. Deepak Sachan
9.	Nominee-1: School of Chemical Sciences	Dr. Bhaskar Mondal
10.	Nominee-2: School of Chemical Sciences	Dr. Garima Agrawal
11.	Nominee-1: School of Biosciences and Bioengineering	Dr. Sumit Murab
12.	Nominee-2: School of Biosciences and Bioengineering	Dr. Kasturi Prasad
13.	Nominee-1: School of Physical Sciences	Dr. Arko Roy
14.	Nominee-2: School of Physical Sciences	Dr. Harsh Soni
15.	Nominee-2: School of Mathematical and Statistical Sciences	Dr. Syed Abbas
16.	Nominee-1: IKSHMA	Dr. Aniruddha Chakraborty
17.	Nominee-2: IKSHMA	Dr. Sumit Murab
18.	Nominee-2: Centre of Human Computer Interaction (HCI)	Dr. Deepak Sachan
19.	Nominee-1: Centre of AI and Robotics	Dr. Narendra Dhar
20.	Nominee-1: School of Humanities & Social Sciences	Dr. Neethi Vadakkan Alexander
21.	Nominee-1: School of Management (SoM)	Dr. Puran Singh, MBA
22.	Nominee-2: School of Management(SoM)	Dr. Ashish Bollimbala, IMBA
23.	CnP Advisor	Dr. Kala Venkata Uday
24.	Deputy Registrar (Academics): Secretary	Mr. Suresh Rohilla
25.	Academic Affairs Secretary	Mr. Pourush Sharma
26.	PG Academic Secretary	Ms. Anugraha
27.	Research Affairs Secretary	Mr. Santu Shit

Following members could not attend the meeting

Sl. No.		Name	
1.	Associate Dean (Research)	Dr. Maheshreddy Gade	Member
2.	Nominee-2: School of Computing and Electrical Engineering	Dr. Gopi Shrikanth Reddy	Member
3.	Nominee-1: School of Mathematical and Statistical Sciences	Dr. Rajendra K Ray	Member
4.	Nominee-1: Centre of Human Computer Interaction (HCI)	Dr. Dinesh Singh	Member

58.1 Confirmation of the minutes of 57th meeting of the Board of Academics:

The minutes of the 57th meeting of the Board of Academics held on 10th October, 2024 were confirmed.

58.2 To consider proposal for B.Tech. in Agricultural Engineering programme:

Dr. Ranjeet Kumar Jha, Nominee from SCENE presented the proposal to start B.Tech. in Agricultural Engineering Programme. After due deliberations, the BoA recommended the proposal for the consideration of Senate and its approval.

The modified proposal is placed as **Annexure – A**

58.3 To consider the proposal to convert the name of B.Tech. in Data science Engineering to B.Tech. in Data Science & Artificial Intelligence:

Dr. Padmanabhan Rajan, Nominee, SCEE presented the proposal to convert the name of B.Tech. in Data Science Engineering to B.Tech. in Data Science & Artificial Intelligence w.e.f. AY 2025-26. After due deliberations, the BoA recommended the proposal for the consideration of Senate and its approval.

Any other item with the permission of the Chair:

58.4 To consider proposal for UG Minor program in Quantum Technology:

Dr. C.S. Yadav presented the proposal for UG Minor Programme in Quantum Technology. After due deliberations, the BoA recommended the proposal with minor modifications to Senate for its consideration and its approval. Due procedure is to be followed for the approval of the course contents.

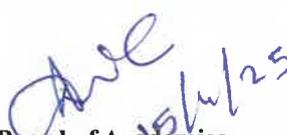The modified proposal is placed as **Annexure – B.**

-NIL-

PART-B

(Issues discussed by the BoA without the Student Members being present)

-NIL-

The meeting ended with a vote of thanks to and by the Chair.

Secretary, Board of Academics

Chairman, Board of Academics

5.	Nominee-2: Centre of AI and Robotics	Dr. Jagadeesh	Member
6.	Nominee-2: School of Humanities & Social Sciences	Dr. Ramna Thakur	Member
7.	Industry Member – 1	Dr. Nadeem Akhtar	Member

Special Invitee

Sl. No.	Name	
1	Dr. Mirza Galib	Asst. Prof., SMSS
2	Dr. Aliva Nanda	Asst. Prof., SCENE
3	Dr. Rajneesh Sharma	Assoc. Prof., SCENE
4	Prof. Arnav Bhavsar	Prof., SCEE
5	Prof. C.S. Yadav	Prof., SPS
6	Dr. Ranjeet Kumar Jha	Asst. Prof., SCENE
7	Dr. Tushar Jain	Assoc., Prof., SCEE

Annexure A

Proposal for B.Tech

in

Agricultural Engineering

School of Civil and Environmental Engineering

Indian Institute of Technology Mandi

Form for proposal of New Programme

Name of the New Proposed Program: B.Tech. in Agricultural Engineering

I.   General Information:

Name (s) of prosper schools/centres **School of Civil and Environmental Engineering, SMME, CAIR, and SBB** (in case of interdisciplinary program, please mention all schools/centres names)

II.   Program Description:

A. Provide a justification/rationale for the program. How does the program relate to the mission of the IIT Mandi?

The Bachelor of Technology (B.Tech.) in Agricultural Engineering program aims to achieve a strong foundation in agricultural sciences with focus on engineering applications by offering a large number of allied engineering courses and employable skills. The idea is to develop a broad B.Tech. curriculum with a blend of agricultural science and engineering covering key elements of soil and water management, farm machinery, irrigation systems, post-harvest technologies, and smart agriculture with hands-on training. The sustainable development of a nation depends significantly on the efficient use of its natural resources, agricultural productivity, and technological advancements in food production and processing. Agriculture plays a pivotal role in ensuring food security, rural development, and the overall economic growth of the country. With the rising global demand for food, coupled with climate change challenges, there is a pressing need to adopt sustainable and innovative agricultural practices that integrate cutting-edge technologies. Modern agricultural engineering bridges traditional farming practices with advancements in soil and water resource management, farm mechanization, food processing, and emerging fields like Smart Agriculture and Artificial Intelligence (AI). These advancements enable precision farming and IoT, improved resource efficiency, and reduced environmental impact, ensuring higher productivity and profitability for farmers.

India, with its large agricultural base, is rapidly adopting smart farming solutions like AI-powered decision support systems, sensor-based irrigation, and automation in food processing. To cater to these demands, it is essential to train high-quality agricultural engineers capable of addressing contemporary challenges and harnessing opportunities in this sector. The proposed B.Tech. program will help us to bridge the gaps between research activities and engineering education, and our graduates would play a leadership role in future growth and industry. Agricultural engineers also offer knowledge of sustainable practices for practical applications that serve as the cornerstone of food security and agricultural productivity across numerous sectors. Further, the proposed B.Tech. program will promote academic and research activities at IIT Mandi and make larger impacts in society by producing high-quality engineers.

B. SWOT analysis of the program

The purpose of SWOT analysis is to see how Agricultural Engineering can be implemented in the IIT Mandi's education system.

Advantages (strengths–opportunities)	Disadvantages (weakness – threats)
The coursework will cover fundamental sciences and mathematics relevant to Agricultural Engineering, as well	Lack of dedicated teaching laboratories for providing hands-on

as provide an in-depth understanding of key agricultural systems, soil and water management, and precision farming.	training to UG students to conduct experiments, familiarizing them with agricultural processes and applications.
This program will educate undergraduate students to tackle grand challenges in food security, sustainable farming, climate resilient agriculture, smart farming technologies, precision agriculture, and automation by selected elective courses in different streams.	Less number of faculty members in the core agricultural engineering areas.
Our graduate students will be trained in R&D to become researchers, innovators, and entrepreneurs who consistently conduct research, develop novel agricultural technologies and processes of all kinds towards positive economic and social impact. This will be achieved by attracting highly motivated students in UG research programs under B.Tech. Honors program.	Limited awareness among students about career opportunities in advanced agricultural engineering compared to traditional engineering disciplines.

Some of the weaknesses could be addressed by establishing good UG teaching laboratories that cater to the needs of a large number of UG students. Similarly, hiring more engineering faculty members in the areas of smart agriculture, agricultural automation, precision farming, and food processing will strengthen the core discipline and also reduce teaching dependencies over associated faculty members from different Schools.

While limited awareness about agricultural engineering may be a challenge, the broad UG curriculum with technical skills, elective specializations, and UG research programs will likely increase the employability of our students in various sectors. Further, more focused efforts are needed to expand the network on identified sectors such as Farm Equipment Manufacturing, Irrigation Systems, Food Processing Industries, Agricultural Startups, and Agri-tech companies in order to improve placements.

C. Justification with respect to National Education Policy (NEP) mandates

One of the major key points of the new national education policy (NEP) is transformational reforms in school and higher education systems in the country and also to foster interdisciplinary education. In the proposed B.Tech. program, greater emphasis is given to connection between the fundamentals and analytical abilities, critical thinking, and research. As per the recent developments, the rigid boundaries among different disciplines are diminishing, and the subject of agricultural engineering is interdisciplinary by itself and would provide broad knowledge to UG students. The field of agricultural engineering gives flexibility for work in a variety of sectors. Graduates receive an in-depth understanding of fundamental sciences and engineering due to the program's resilience. Due to the program's integration of agricultural sciences and engineering, graduates benefit from having a degree that allows them to be flexible enough to work in a variety of industries while also being highly qualified for advanced study and research.

D. Provide a mission statement for the program. Include educational and learning objectives

The Bachelor of Technology in Agricultural Engineering program's mission is to prepare graduates with a solid foundation in agricultural science and engineering to fulfill the demands of industry,

government, and academia, as well as to pursue further academic study in fields connected to agriculture. This will be done by giving students access to up-to-date curricula, state-of-the-art labs, chances to collaborate on cutting-edge research with eminent faculty mentors, and opportunities to get involved in leadership and service projects.

The educational and learning objectives of the B.Tech. in Agricultural Engineering program are:

- Our graduates will quickly advance to leadership positions in organizations that deal with agricultural systems in industry, academia, government, and other fields of endeavor.

- Our graduates will be entrepreneurs who continuously research, develop, and produce novel agricultural technologies and systems of all kinds, having a beneficial economic and social influence on their industry and society as a whole.

- Our graduates will be trained to become world leaders who integrate cutting-edge engineering and agricultural breakthroughs that are improving society and the state of the human condition while working with diverse, multidisciplinary teams.

- Our graduates will be equipped with knowledge and skills to address global challenges related to food security, sustainable agriculture, and climate-resilient farming practices.

E. Credit Structure of the programme

Division	Sub-division	Credits
Institute Core	IC Compulsory	32
	IC Baskets	6
	HSS	12
	IKSHMA	3
Discipline	Discipline Core	49
	Discipline Electives	17
Electives	Free Electives	22
	*FDP+DP+MTP + ISTP or Equivalent	19
	Total	**160**

The credit structure will be followed as per the existing norms of the institute. Out of 160 credits, 49 credits will be dedicated to discipline courses. Total of 17 credits will be assigned for discipline electives wherein few optional baskets will be introduced for promoting B.Tech. Specialization for 15 credits. Total of 66 credits will be maintained for DC (49 credits) and DE (17 credits) courses while the rest of the credits will be kept for IC and other institute level courses (90 credits).

F. List of courses proposed

IC Courses / Basket	Core Courses	Discipline Electives
1. Internship	16. Hydraulic Engineering	1. Heat transfer and lab
2. Complex and Vector Calculus	17. Hydraulic Engineering Lab	2. Engineeing Thermodynamics
3. Linear Algebra	18. Soil Science and Mechanics	3. Remote Sensing and GIS
4. ODE & Integral Transforms	19. Surveying Traditional and Digital	4. Sustainable Agriculture Waste Management
5. Graphics for Design	20. Farm Machinery & Equipment	5. Agricultural Risk Assessment
6. "Introduction to Python and Data Science	21. Irrigation and Hydraulic Structure	6. Robotics and Drones in Agriculture
7. (Computing and Data Science/ Data Science I)"	22. Water Resources Engineering	7. Agricultural Information and Database Management system
8. Applied Electronics	23. Crop Production Technology (Field & Horticulture crop)	8. Automated Climate Controlled Agriculture
9. Applied Electronics Lab	24. IoT Systems and Clouds	9. Bio-process engineering
10. Physics Practicum	25. Strength of Materials and Structure	10. Food packaging
11. Calculus	26. Strength of Materials and Structure Lab	11. Tractor and Power System
12. Probability and Statistics (Data Science II)	27. Theory and Design of Machine Elements	12. Product Realization Technology
13. Machine Learning (Data Science III)	28. Food Science & Technology	13. Soil water conservation Engineering
14. Environmental Science	29. Food Science & Technology Lab	14. Smart Automation in Agriculture
15. Mechanics of Rigid Bodies	30. Post-Harvest Engineering	15. Smart Automation in
	31. Self-Sufficient Farming (Natural Farming)	
	32. Control Systems Engineering	
	33. Civil Engineering Drawing	

			16.	Agriculture – Open Field Lab Smart Automation in Agriculture – CCA Lab

G. Provide a list of any current courses that would be cross-listed with the program:

1. Water Resources Engineering
2. Hydraulic Engineering and Lab
3. Surveying Traditional and Digital
4. Irrigation Engineering and Hydraulic Structure
5. Civil Engineering Drawing
6. Heat transfer and lab
7. Engineering Thermodynamics
8. Remote Sensing and GIS
9. IoT Systems and Clouds
10. Control Systems Engineering
11. Strength of Materials and Structure
12. Strength of Materials and Structure Lab
13. All IC and IC basket courses are the same as SCENE

H. What, if any, new courses will be required for the program? A separate course proposal is required for each new required course.

Being a new B.Tech. program, around 20 new courses will be proposed with required details. At the same time, some of the existing courses in the subject of Civil and environmental Engineering, Mechanical Engineering and Computer and Electrical Engineering will be adopted as per the requirement. Separate course proposals are being prepared and will be submitted in the due course.

I. Provide a sample academic plan for students completing the academic program being proposed.

SEMESTER 1

Sl. No.	Course Code	Course Name (Place Holder)	Credits
1	IC140	Graphics for Design	4
2	IC11A	Math 1	2
3	IC11B	Math 2	2
4	IC152	Introduction to Python and Data Science (Data Science I)	4
5	IC230	Environmental Science	3
6	HSXXX/IKXXX	HSS Course/IKSHMA Course	3
		Total Credit	**18**

Semester 2

Sl. No.	Course Code	Course Name (Place Holder)	Credits
1	IC11C	Math 3	2
2	IC11D	Math 4	2
3	IC161	Applied Electronics	3
4	IC161P	Applied Electronics Lab	2
5	IC240	Mechanics of Rigid Bodies	3
6	IC252	Probability and Statistics (Data Science II)	4
7	IKXXX/HSXXX	IKSHMA Course/HSS Course	3
		Total Credit	19

Semester 3

Sl. No.	Course Code	Course Name	Credits
1	AGXXX	Crop Production Technology	3
2	AGXXX	Soil Science and Mechanics	4
3	CE301, CE301P	Strength of Materials and structure	4
4	IC272	Machine Learning (Data Science III)	3
5	DE-1	DE (Engineering Thermodynamics)	4
6	AGxxX	Farm Machinary and Equipment	3
7	IC201P	Design Practicum	3
		Total Credits	24

Semester 4

Sl. No.	Course Code	Course Name (Place Holder)	Credits
1	CE201	Surveying Traditional and Digital	4
2	CE251	Hydraulics Engineering	3
3	AGXXX/EE301	Control system Engineering	4
4	AGXXX	Theory and Design of Machine ELEMENTS	4
5	CE304P	Hydraulics Engineering Lab	1
6	HSXXX	HSS Course	3
7	IC-222P	Physics Practicum	2
		Total	21

SEMESTER 5

Sl. No.	Course Code	Course Name (Place Holder)	Credits
1	CE303	Water Resources Engineering	3
2	CE451	Irrigation and Hydraulic Structure	3
3	CS541P	IoT Systems and Clouds	3
4	AGXXX	Food Science and Technology and Lab	4
5	CE353P	Civil Engineering Drawing	1
6	HSXXX	HSS Course	3
7	AGXXX	Self-Sufficient Farming (Natural Farming)	2

8	FE-1	Free Elective	3
		Total Credit	**22**

After Semester 5

Sl. No.	Course Code	Course Name (Place Holder)	Credits
1	IC 010	Internship	2

Semester 6

Sl. No.	Course Code	Course Name	Credits
1	FE-2	Free Elective	3
2	DE-2	DE (Smart Automation in Agriculture, Theory, Open Field Lab, CCA Lab)	4
3	AGXXX	Post-Harvest Engineering	3
4	DE-3	DE(Soil and water conservation Engineering)	3
5	FE-3	Free Elective	3
6	DP301P or Equivalent	ISTP or FE	4
7	DE-4	Discipline Electives	3
		Total Credits	**23**

Semester 7

Sl. No.	Course Code	Course Name	Credits
1	DE-5	Discipline Elective	3
2	FE-4	Free Elective	4
3	HSXXX	HSS Courses	3
4	FDP*/DE-6	FDP/DE	4
5	CE498P or Equivalent	Major Technical Project (MTP-I) or DE	3
		Total Credits	**17**

Semester 8

Sl. No.	Course Code	Course Name (Place Holder)	Credits
1	FE-5	Free Elective	3
2	FE-6	Free Elective	3
3	FE-7	Free Elective	3
4	CE499P or Equivalent	Major Technical Project (MTP-II) or DE	5
		Total Credits	14

- **Instead of FDP students can opt for DE.**

Discipline Electives
1. Heat transfer and lab
2. Engineeing Thermodynamics
3. Remote Sensing and GIS
4. Sustainable Agriculture Waste Management
5. Agricultural Risk Assessment

---

6. Robotics and Drones in Agriculture
7. Agricultural Information and Database Management system
8. IoT Systems and Clouds
9. Computer Network
10. Automated Climate Controlled Agriculture
11. Bio-process engineering
12. Food packaging
13. **Tractor and Power System**

J. **If established at other institutions, please submit sample programs from those institutions.**

1. In what ways is this proposal consistent with those programs?

The new agricultural engineering curriculum, while innovative in many aspects, maintains several core consistencies with the IIT Kharagrpur program. Both curricula prioritize fundamental engineering principles as the backbone of agricultural education, preserving courses in fluid mechanics, soil technology/science, thermodynamics, and machine design. The traditional focus areas of agricultural engineering - irrigation systems, water resource management, farm machinery, and food processing - remain central to both programs, recognizing their enduring importance to the discipline. Both curricula maintain a similar overall structure with a progression from basic sciences and engineering fundamentals in earlier semesters to specialized agricultural applications in later years. The multidisciplinary nature of agricultural engineering is acknowledged in both programs through the inclusion of courses spanning mechanical engineering, electronics, environmental science, and biological systems. Laboratory components remain essential in both curricula, with hands-on practical training complementing theoretical knowledge across various subjects. The food engineering and food science components are preserved in both programs, recognizing the critical connection between agricultural production and food processing. Both curricula also maintain engineering drawing and graphics courses, emphasizing the importance of visual communication in engineering design. Additionally, both programs incorporate elements of economics and business principles, acknowledging that agricultural engineers must understand both technical and economic aspects of agricultural systems. Despite the new program's stronger emphasis on digital technologies and sustainability, it respects the traditional core that has defined agricultural engineering education at institutions like IIT Kharagrpur, evolving the discipline rather than reinventing it entirely.

2. In what ways is this proposal different from those programs? Please explain those differences.
The new agricultural engineering curriculum represents a substantial evolution from IIT Kharagpur's traditional approach. The most striking difference is the new curriculum's emphasis on digital agriculture, with courses in Python, data science, machine learning, and AI applications specifically for agricultural contexts. Unlike IIT Kharagpur's broader approach, the new program clearly organizes courses into four specialized tracks: Soil and Water Resources Engineering, Farm Machinery and Power, Smart Agriculture and AI, and Food Processing, allowing for more targeted expertise development. Another significant advancement is the integration of sustainable and future-oriented agricultural practices through courses on natural farming, agricultural waste management, robotics, drones, and automated climate-controlled agriculture – topics largely missing from the IIT Kharagpur syllabus. The humanities and soft skills component has also been restructured into six distinct competence baskets covering creative understanding, language, communication, social aspects,

management, and free electives, providing more comprehensive personal development than IIT Kharagpur 's limited offerings. Additionally, the new curriculum incorporates explicit internship requirements and flexible project substitution options. Overall, this redesign shifts from IIT Kharagpur 's traditional engineering-centric approach toward preparing students for agriculture's technological future while balancing technical expertise with sustainability concerns and professional soft skills.

II. **Faculty and Governance:**
Provide a list of the faculty available to teach courses for this program.
1. Dr. Aliva Nanda (SCENE)
2. Dr. Ranjeet Kumar Jha (SCENE)
3. Dr. Dericks P Shukla (SCENE)
4. Dr. Vivek Gupta (SCENE)
5. Dr. Uday V Kala (SCENE)
6. Dr. Harshad K. Kulkarni (SCENE)
7. Dr. Sayantan Sarkar (SCENE)
8. Dr. Atul Dhar (School of Mechanical and Materials Engineering)
9. Dr. Tushar Jain (School of Computing and Electrical Engineering)
10. Dr. Shyam K. Masakapalli (School of Biosciences and Bioengineering)
11. Dr. Radhe Shyam Sharma (School of Computing and Electrical Engineering)
12. Dr. Amit Shukla (CAIR)
In case of interdisciplinary program, mention governances and execution mechanism of the programme:

Agricultural Engineering program is an interdisciplinary program and a good number of the allied courses will be taught by faculty members from Civil Engineering, Environmental Engineering, Mechanical Engineering, and Computer Science. While the core faculty in SCENE will take a lead in governance and overall coordination, the associated faculty members from other streams will be contributing to teaching activities as per the need and their availability to bring out the best in this interdisciplinary program. Recruitment of around a few more faculty members in the area of Agricultural Engineering with expertise on smart agriculture, precision farming, agricultural automation, and other advanced areas are needed in the next few years.

III. **Student interest:** What measures of student interest in the program are there? How/why are the proposers convinced that students would want to take this program of study? (Attach Career and Placement Cell recommendation or any other)

The agricultural sector is undergoing rapid transformation with the integration of technology. The proposed B.Tech. in Agricultural Engineering would be attractive to students who have an inclination towards addressing challenges in food security, sustainable agriculture, and climate resilience through engineering solutions. Being an interdisciplinary program, this will also cater to students who would like to pursue different fields at the master level.

The demand for agricultural engineers is expected to grow with the increasing adoption of precision agriculture, smart farming technologies, and sustainable agricultural practices. With the government's emphasis on doubling farmer income and promoting agricultural entrepreneurship, graduates with expertise in agricultural engineering will have diverse career opportunities.

To enhance employability, 4 different specialization programs via elective baskets are added as part of the B.Tech. program. With such exposure, the employability of students is expected to be higher considering the developments in agricultural technology, food processing, and sustainable farming sectors. Finally, our UG program at IIT Mandi is sufficiently broad, covering key elements of general engineering, sciences, humanities, and more importantly, computer and data sciences that would enable students to get jobs in non-core areas/software sectors if they choose to pursue those paths.

Resources:
Additional requirements of laboratory space with justification (name of the labs)

1. Soil and Water Engineering Laboratory (required space = 1500 sqm)

2. Agricultural Machinery Laboratory (required space = 3000 sqm)

3. Post-Harvest Processing Laboratory (required space = 1000 sqm)

4. Smart Agriculture and Precision Farming Laboratory (required space = 1500 sqm)

5. Smart Automation Greenhouse Lab (required space = 500 sqm

6. Agricultural Data Analytics Laboratory (required space = 200 sqm)

7. Agricultural Systems Design Laboratory (required space = NA)

8. Natural Farming Laboratory (required space = 1000 sqm)

Additional requirements of laboratory fund (recurring and non-recurring) with justification (name of the labs)

1. Soil and Water Engineering Laboratory (Equipment: 2 crores)

2. Agricultural Machinery Laboratory (Equipment: 5 crores)

3. Post-Harvest Processing Laboratory (Equipment: 2.5 crore)

4. Smart Agriculture and Precision Farming Laboratory (Equipment: 2.5 crores)

5. Agricultural Data Analytics Laboratory (PC and Software packages: 70 lakhs)

6. Agricultural Systems Design Laboratory (Nil)

7. Recurring budget (Consumables: 20 lakhs)

8. Infrastructure budget for the laboratory needs to be worked out by the I & S section.

Additional requirements of faculty and non-teaching staff (Numbers and justification)

1. Around a few more faculty members with engineering background are needed to cater to the broad curriculum with a large number of elective courses.

2. For laboratory management, around 4 lab assistants are needed.

IV. Origin and development of the proposal:
- Please mention the name for faculty involved in developing this proposal.
    1. Dr. Aliva Nanda
    2. Dr. Ranjeet Kumar Jha

- **Details of external industry experts and their recommendations (please include their evaluation)**
    1. Ashutosh Pandey, Assistant Director - Analytics & Modeling, Moody's.
    2. Aseem Garg, Consultant, Deloitte Touche Tohmatsu India LLP.

Detailed comments and their reply are given in the Appendix.

- **Details of external academia experts and their recommendations (please include their evaluation):**

1. Dr. Adarsh Kumar, Principal Scientist, Indian Council of Agricultural Research (ICAR), New Delhi, India.

2. Dr. Shyam Narayan Jha, Dy. Director General, ICAR

3. Prof. Sudhanshu Panda, Professor, University of North Georgia, USA.

4. Prof. Madan K. Jha, IIT KGP

5. Prof Chandranath Chatterjee, IIT KGP

Detailed comments and their reply are given in the Appendix.

- Proposers faculty name and their signatures :

Name of Faculty members	Signatures
1. Dr. Aliva Nanda	
2. Dr. Ranjeet Kumar Jha	
3.	
4.	

Recommendations of Chairperson of School/ Centre
Signature with Date:

Dean (Students) recommendations on availability of hostels and other requirements:
Signature with Date:

Associate Dean (Courses) recommendation on class rooms availability and other academic infrastructure requirements :
Signature with Date:

Dean Finance recommendation on financial aspects (if any)
Signature with Date:

Dean Academics recommendations:
Recommended/Not Recommended
Signature with Date:

Appendix:

Industry experts:

1. Ashutosh Pandey, Assistant Director - Analytics & Modeling, Moody's.

Comment 1: If "Linear Algebra" is not already part of the core structure, I highly recommend including it as a core course, as it is fundamental to the subject.

Response: Linear Algebra is already being taught under IC Core course (IC 114).

Comment 2: If partial differential equations (PDEs) are not included in the curriculum, they should be integrated into the Calculus course to enhance mathematical foundations. It could be a basic introduction, instead of a deep course structure.

Response : PDEs is already included in our calculus curriculum.

Comment 3: 2-part course structure for industry relevancy:

Fundamentals of Data Science and AI in Agriculture - Semester 5 or 6 - Core Course

Applied Data Science in Agriculture - Semester 7 or 8 (Project Based) – Elective

Response: We already have dedicated courses to AI and ML (Data Science I,II, and III).

2. Aseem Garg, Consultant, Deloitte Touche Tohmatsu India LLP.

Comment 1: Having reviewed the curriculum, I would like to suggest the inclusion of two critical subjects as Discipline Electives: IoT Systems and Cloud Computing and Robotics and Drones in Agriculture

Response: These two courses are included in the DC/DE.

Academia experts

1.Dr. Adarsh Kumar, Principal Scientist, Indian Council of Agricultural Research (ICAR), New Delhi, India.

Comment 1:

The curriculum is perfect, maybe you can consider the following observation.

Table 2: List of IC Compulsory Courses

Introduction to Agricultural Engineering- 2 CREDITS

Response: Initially, we added it to the IC course, but unfortunately, the IC courses can't

be modified. As students gain exposure to courses across various specializations, they will develop deeper insights into Agricultural Engineering. However, due to the current credit limitations, it is not feasible to accommodate this within the existing program structure.

Comment 2: Sensors must be part of "Smart Automation in Agriculture." Table 5: Discipline Core Courses.

Response: We have already added the suggested component in the listed DC/DE courses (AGXXX-Smart Automation in Agriculture).

Comment 3: Agricultural Risk Assessment can be a "Technology/technique for Agricultural Risk Assessment" (Table 6: Discipline Electives)

Response: The course name will be modified with discussion with the course development team.

2. Dr. Shyam Narayan Jha, Dy. Director General, ICAR

Comment 1: Total credits of 160 appears little low. Around 180 for IIT KGP and 6th Deans Committee report being followed in all Agricultural University).

Response: The course credit distribution for the proposed program follows the institute policy, maintaining a uniform credit structure across all schools.

Comment 2: Under IC group I do not see any course on modern fabrications/manufacturing (course being offered to other B.Tech. Engg. may be taken for here too).

Response: We have added Product Realization Technology (IC141 –Revised) in departmental electives.

Comment 3: Basic electronics (particularly basic theory and fabrications practical should be kept for modern age Agricultural Engineer)

Response: This course is already being offered under IC Core course – Applied Electronics (IC 161).

4) Under Discipline core courses

Comment 4a: The Two subjects   i)Crop Production Technology - I (Field crops) & ii) Crop Production Technology - II (Horticultural crops) may be modified as i) Crop Production Technology - I (Field and Horticultural crops) & ii) Livestock Production Technology - II Comment 4b: The courses on natural farming may be omitted. Even B.Sc Ag (6th Deans Committee) has only 2 credit hour course. These may be covered in Crop/animal production technologies courses as a module. Instead of these, courses on heat and mass transfer and unit operations needs to be added with 4 credits.

Response: The proposed program has been holistically designed to help students understand agricultural ecology, promote the principles of sustainable agriculture, and recognize the health and environmental impacts of food production. In this context, Natural Farming is a critical component and must be included to equip students with knowledge of ecologically sound and resource-efficient farming practices.

Comment 4c: In farm machinery two courses one on Farm machinery design and another on Dynamics of soil tillage and traction need to be added. Courses on tractors engines, loads etc need to be added.

Response: Farm machinery design will be covered under Theory and Design of Machine Elements course, and other components will be part of discipline elective course - Tractor and Power System.

Comment 4d: Principle of soil sciences and Soil mechanics have to be covered somewhere.

Response: The suggested course will be taught as a discipline core.

Comment 4e: Irrigation wells and pumps, Soil and Water Conservation Structures need to be added.

Response: These two courses will be covered under Irrigation Engineering and Hydraulic Structures, and Soil and Water Conservation Engineering, respectively.

Comment 4f: Food Safety and quality courses covering its basics and their determinations techniques (including nondestructive methods).

Response: This component is already part of the discipline core course – Food Science & Technology.

Comment 5: In Discipline electives: A course of Bioprocess Engg of 3 credits may be thought of to deal with secondary agriculture and high value addition.

Response: The suggested course is already part of the discipline elective.

Comment 6: A course on Instrumentation and process controls of 3 or 4 credits may be added.

Response: This component will be covered under Basic Electronics Lab, which is an IC Core course.

Comment 7: For name of Degree, I will suggest to have "Agricultural & Food Engineering" as in IIT Kharagpur. Hope attached file will help you finalize soon. Even if any thing requires, let me know.

Response: The final name of the degree program will be determined in consultation with the Board of Academics (BoA), taking into account employment opportunities and ensuring that the chosen title aligns with student career prospects.

3. Prof. Sudhanshu Panda, Professor, University of North Georgia, USA.

Comment 1: In the Institution Compulsory, I have added a NEW course, Natural Geohazards Proactive Management DSS. For IIT Mandi should be pioneer in developing this course because of its natural, geospatial, and environmental association in present day climate change scenario…It should be taught to all program majors…Agriculture Engineering Program must develop it.

Response: This suggestion will be duly considered for the development of a future development of an IC Course, potentially benefitting students across all programs, including this proposed program in agricultural engineering.

Comment 2: In HSS/ISTP, MTP section, I have added an Engineering Seminar course in Communicative Competence section. It would be 1 credit and all students must attend to learn how to review research literatures and know about research principles through invited faculties to each class…

Response: The suggested course is already part of HSS.

Comment 3: Discipline Core, I did not change anything…It is good and involve advanced courses that are necessary in present day innovation period…

Response: Thank you for your appreciation

Comment 4: In Discipline Elective, I have added few advanced courses, such as i) Precision Climate-Smart Agriculture, ii) GeoAI Spatial Modeling in Agriculture DSS Development or Plain GeoAI in Ag DSS courses as they are the evolving technology-based courses in Agriculture…Check notes…

Response: Precision Climate-Smart Agriculture will be taught under the specialization in smart agriculture and AI. Furthermore, GeoAI and DSS related components will be covered under Remote Sensing and GIS, Hydroclimatology, and other smart agriculture courses.

Comment 5: I have deleted Tractor and Power Systems as it is very old type course and also taken out

Computer Network (Telemetry) and suggested to add to IoT Systems and Clouds (Ag Instrumentation sans heavy machinery like tractors, power tillers, hydraulic pumps, etc.) as both complement to each other and must be taught together. For Ag. Engineers, it is a MUST course and especially, in India, where we do not learn about instruments and its actual in-situ applications for Agricultural Management DSS development. Think about moving this course to the Discipline Core section…

Response: The developed course curriculum approach at IIT Mandi will first teach the students about Tractor and Power Systems, and then IoT systems and clouds will be taught under discipline elective. Therefore, interlinking of these courses will provide them from the fundamental concept of tractor and power to the advanced systems used in these farm machineries.

Comment 6: In Free Elective section, I have added two new courses, i.e., Watershed Characterization and Agro-ecosystems and they are very advanced courses needed in the Climate Change area.

Response: The suggested component will be covered under Soil and Water Conservation Engineering.

4. Prof. Madan K Jha, Professor & HOD, IIT Kharagpur

Comment 1: Keep in mind that students must take fundamental courses and core courses in Agricultural Engineering.

Subjects like Soil Physics, Engineering Mathematics, Thermodynamics, Irrigation and Drainage Engineering, Soil and Water Conservation Engineering, Instrumentation Engineering, Surface Water Hydrology, Groundwater Hydrology, Surveying, and Soil Mechanics, etc., should be taught at the UG level along with Fundamentals of AI/ML and its application in Agriculture, Data Science, and Robotics.
Response: All these courses have been covered under DC/DE.

5. Prof. Chandranath Chatterjee, Professor, IIT Kharagpur

I had a look at your curriculum. It is well-designed and covers new subjects pertinent to the new developments in the field of Agricultural Engineering. I have a few observations:

Comment 1: The course 'Soil and Water Conservation Engineering' is under 'IC Basket Courses'. It doesn't look very appropriate here. It should be either in Discipline Core or Discipline Electives.

Response: The suggested course has been moved under the discipline elective courses.

Comment 2: There should be a 'BTP - Bachelor's Thesis Project'. It helps students to get insight into a particular topic in which they are interested.

Response: IIT Mandi is offering Thesis Project for Bachelor's program under MTP I and II.

Comment 3: There should be more number of subjects under 'Discipline Electives and Free Electives'. You can have a look at the new AgFE curriculum of IIT KGP.

Response: We will keep adding more number of Discipline Electives and Free Electives as the proposed program progresses.

Comment 4: Many Institutes are nowadays offering a 'Semester Away Internship Programme (SAIP)' to the students. The students can take a semester off from their Institute and have practical experience in an Industry or another Research Institute. This helps in providing a good exposure to the students.

Response: IIT Mandi also offers this program for B.Tech. students.

Syllabus for UG Minor program in Quantum Technology

Table of Courses

Course code	Title	Credits (Theory: Lab)
QT 01 and QT 02 are both Mandatory		
QT 01	Survey of Quantum technologies and Applications	3:0
QT 02	Foundations of Quantum Technologies	3:0
At least one of QT 03 and QT 04 is Mandatory		
QT 03	Basic Programming Lab	2:1
QT 04	Basic Laboratory Course for Quantum Technologies	2:1
At least one of QT 05, QT 06, QT 07, QT 08 is Mandatory		
QT 05	Introduction to Quantum Computation	3:0
QT 06	Introduction to Quantum Communication	3:0
QT 07	Introduction to Quantum Sensing	3:0
QT 08	Introduction to Quantum Materials	3:0
Optional / Additional Courses		
QT 09	Engineering Foundations of Quantum Technologies	3:0
QT 10	Solid State Physics for Quantum Technologies	3:0
QT 11	Quantum Optics	3:0

Prerequisites for all courses:

Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model curriculum.

IIT Mandi
Proposal for a New Course

Course Name	: **Survey of Quantum Technologies and Applications**
Course Number	: QT 01
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

1. **Preamble:** This course is meant to give an overview of the field of quantum technologies and make the students familiar with the state-of-the-art in all four verticals. The emphasis is not on depth in this course, but on covering the exciting aspects of the field. Students of this course learn: (i) The general physical principles of realising qubits for computation, (ii) The various hardware implementations of qubits for computation, (iii) The basic ideas of quantum sensing, (iv) The applications of quantum sensing, (v) The implementations of quantum communications protocols in fibre-based and free-space

2. **Course Content:**

- Quantum Technologies – four verticals   (1 lecture)
    - Motivation for Quantum Technologies
- A qualitative overview of salient aspects of quantum physics   (4-5 lectures)
    - Quantum States, Wavefunctions, Probabilistic interpretation
    - Physical observables, Hermitian operators, expectation values
    - Heisenberg uncertainty principle
    - Schrodinger equation, Time evolution
    - distinction from classical physics
    - Heuristic description of Superposition, Tunnelling and entanglement
    - No cloning theorem
    - Simulating classical systems – Feynman's idea of a quantum simulator and the birth of the field
- Quantum Computation   (10-12 lectures)
    - Basics of qubits -- what is a qubit?
    - How is it different from a classical bit? – Review of classical logic gates
    - Di Vincenzo criteria for realising qubits
    - Basics of qubit gates and quantum circuits
    - Physical implementation of qubits (very qualitative description)
        - Solid State Qubits
            - Semiconducting Qubits – quantum dots, spins

- - - Superconducting Qubits – charge, flux and phase
      - Topological Qubits – proposals and advantages
    - Atoms and Ions
      - Trapped ions
      - Rydberg atoms
      - Neutral atoms
    - Photonic Qubits
      - Conventional linear optical setups
      - Integrated Photonics
    - NMR qubits
      - Conventional NMR qubits
      - NV centres
  - Overview of applications and recent achievements
    - RSA and Shor's algorithm
    - Quantum Advantage
  - Long term goals and strategies being followed
    - Error correction
- Quantum Sensing   (8-10 lectures)
  - Basics of quantum sensing
  - Basics of Photon (single and entangled) generation and detection
  - Gravimetry
  - Atomic clock
  - Magnetometry
  - State of the art in Quantum Sensing
- Quantum Communications (8-10 lectures)
  - Basics of digital communication
  - Quantifying classical information – Shannon entropy
  - Basic ideas of quantum communication, security, eavesdropping
  - Overview of quantum communication achievements
    - Terrestrial – fibre-based
    - Free space, Satellite-based

3. Course Test Books and References:

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
2. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
3. Elements of Quantum Computation and Quantum Communication, A. Pathak, Boca Raton, CRC Press (2015)
4. An Introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme, and Michele Mosca, Oxford University Press (2006)
5. Quantum computing explained, David McMahon, Wiley (2008)

4. Similarity Content Declaration with Existing Courses:

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

5. Justification for new course proposal if cumulative similarity is >30% :   NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair   **School/Center:** CQST

Signature: ....   Date: ....

....

Recommended/Not Recommended, with Comments:

                                                              Date: ....

_____
            Chairman, CPC

Approved/Not Approved

                                                              Date: ....

_____
          Chairman, Senate

IIT Mandi
Proposal for a New Course

Course Name	: **Foundations of Quantum Technologies**
Course Number	: QT 02
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: This course is meant for laying down the central theoretical aspects of quantum mechanics in a rigorous manner where students learn the techniques and develop a good intuition for quantum physics. Students of this course learn (i) The most relevant mathematical techniques (ii) Basic postulates of quantum mechanics and applications, (iii) Basics of Statistical Physics, (iv) Basics of Information Science, (v) Basics of computational complexity

1. Course Content and syllabus:

- Quantum Mechanics (16 - 18 lectures):
    - Brief overview of classical physics (This segment is meant for the student to understand what a Hamiltonian is, which will feature later in quantum mechanics)
        - Hamiltonian function and Hamilton's equations
        - Phase-space description of a system
        - Connection and Equivalence with Newton's laws for simple systems – free particle, particle moving in a conservative potential, examples of Harmonic oscillator, hydrogen atom
    - Historical evolution of quantum mechanics
        - Planck's quantum hypothesis
        - Photo electric effect
        - Atomic spectra
        - Bohr's quantisation principle
        - De Broglie's Wave particle duality
    - Postulates of Quantum Mechanics
        - State vectors and Hilbert Space
        - Dirac Bra-Ket notation
        - Measurables and Hermitian Operators
        - Unitary Transformations
        - Schrodinger Equation and Time evolution of quantum states
        - Measurement Postulate
        - Schrodinger, Heisenberg and Interaction pictures

- - Eigen values, Expectation values and Matrix elements
    - Heisenberg's Uncertainty principle
  - Density operator formalism of quantum mechanics – pure and mixed states
  - Superposition and Entanglement in quantum mechanics
  - No cloning theorem
  - Applications of postulates –Particle in a box, Hydrogen atom, Harmonic Oscillator
  - Number states, ladder operators and Coherent states of a harmonic oscillator
  - Spin and Angular momentum – spin half particles
  - Rabi problem of a spin-half particle in a rotating magnetic field
  - Bosons and Fermions
- Statistical Physics (8-10 lectures)
  - Quick review of first and second laws of thermodynamics
  - Thermal Equilibrium and Gibbs principle
  - Applying Gibbs principle to Classical and Quantum harmonic oscillators
  - Bosons and Fermions and Quantum statistics – Fermi-Dirac and Bose-Einstein distributions
- Information Science (3-4 lectures)
  - Digital communication and information
    - Quantifying information in terms of Shannon entropy
  - Basic ideas of quantum information
  - Decoherence and noise
  - Introductory ideas of Kraus operators
- Brief overview of Computational Complexity (5-6 lectures)
  - Qualitative ideas of a Turing machine
    - Types of Turing machines
  - Time and Space complexity – P vs NP, PSPACE
  - Quantum complexity classes – Q, EQP, BQP, BPP, QMA
  - Post Quantum Cryptography (PQC)

Course References:

1. Introduction to Quantum Mechanics, Griffiths D. J., 3rd Edition, Cambridge University Press (2024)
2. Introduction to Electrodynamics, Griffiths D. J., 4th edition, Cambridge University Press (2020)
3. Principles of Quantum Mechanics, Shankar, R., 2nd edition, Springer (2014)
4. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
5. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
6. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
7. Information Theory, Robert B. Ash, Dover Publications (2003)

8. Introduction to the Theory of Computation, Michael Sipser, 3ʳᵈ edition, Cengage India Pvt. Ltd. (2014)
9. Statistical Mechanics, Pathria R. K., Paul D. Beale, 4ᵗʰ edition, Academic Press, (2021)

6. Similarity Content Declaration with Existing Courses:

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

7. Justification for new course proposal if cumulative similarity is >30% :   NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair   **School/Center:** CQST

Signature: ………………..   Date: ……………..

……

Recommended/Not Recommended, with Comments:

Date: ……………

_____
Chairman, CPC

Approved/Not Approved

Date: ……………

_____
Chairman, Senate

IIT Mandi
Proposal for a New Course

Course Name	: **Basic Programming Lab**
Course Number	: QT 03
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: This course is meant to provide students a quick hands-on experience in scientific computing and its applications to areas within Quantum Technologies. Students of this course learn (i) Basics of programming, (ii) To write programs to solve scientific problems, (iii) Techniques for scientific computing, (iv) Applications to quantum mechanics and electromagnetism

1. Course Content and syllabus:

- Basics of programming
    - Data structures, classes, Object-oriented programming
    - Data storage and retrieval, Memory allocation
    - Scientific plotting, documentation of codes
- Simple algorithms and benchmarking run time
    - Sorting
    - Searching
    - Arithmetic algorithms like GCD, Prime factorisation
- Numerical Integration and differential equations
    - Linear 2nd Order ODEs with constant coefficients
    - Linear 2nd order ODEs with variable coefficients
    - Boundary value problems
        - Poisson equation
        - Laplace equation
        - Wave equation
        - Diffusion Equation
- Numerical techniques in linear algebra
    - Matrix inverse
    - Eigenvalue problem
    - Diagonalisation of matrices
    - Singular value decomposition
- Numerical techniques in Probability and Statistics
    - (Pseudo) Random number generation
    - Computing statistical moments for data samples
    - Least Squares fitting

- o Error Analysis
- o Hypothesis Testing
- o Monte Carlo sampling
- Applications to Quantum Mechanics (can be done using openly available modules in languages like Python, Julia etc.)
  - o Eigen energies of coupled two level systems
  - o Eigen energies of two-level system coupled to oscillator (Jaynes-Cummings Model)
  - o Driven two-level system – Rabi Problem
  - o Driven damped oscillator — coherent states
- Applications to EM theory (e.g. magnetic field simulation)
  - o Electrostatic charge distributions
  - o Magnetostatic current distributions
  - o Finite Element techniques for electromagnetic simulations

Course References:

Computational Physics, Nicholas Giordano, Hisao Nakanishi, 2nd edition, Pearson-Addison Wesley (2005)

Similarity Content Declaration with Existing Courses:

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

Justification for new course proposal if cumulative similarity is >30% : NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair   **School/Center: CQST**

Signature: ....   Date: ....

....
Recommended/Not Recommended, with Comments:

_____   Date: ....

Chairman, CPC

Approved/Not Approved

_____   Date: ....

Chairman, Senate

IIT Mandi
Proposal for a New Course

Course Name	: **Basic Laboratory Course for Quantum Technologies**
Course Number	: QT 04
Credits	: 2-0-1-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: This course is meant to provide students a quick hands-on experience in requird for understanding and the applications to areas within Quantum Technologies. Students of this course learn (i) Basic experimental techniques in optics, (ii) Basic experimental techniques in characterising resonators and RLC circuits, (iii) Basic digital circuits, (iv) Fundamental techniques in RF engineering, (v) Interfacing instruments with computers and carry out data acquisition

Course Content and syllabus:

- Optics
    - Interferometry – wavelength measurements, intensity measurements
    - Diffraction – single slit, grating
    - Microscopy – magnification, aberration
    - Polarization optics – PBS, HWP, QWP
- RLC circuits
    - Series and parallel RLC circuits – Verifying the quality factor formulae
    - Extracting intrinsic losses
- Digital circuits
    - Adder, Multiplier
    - Encoder, Decoder
    - D flipflop, shift registers
    - How to use common Integrated Circuit chips
- Radio Frequency Technology:
    - Using Oscilloscope
        - Ring-up and ring-down time measurements of RLC circuits
        - Measurements of different pulse-shapes generated by a function generator
    - Using Vector Network Analyser
        - Transmission and reflection measurements of coaxial cable in open, short and matched termination
        - Voltage standing wave ratio measurement

- ■ Amplitude and Phase quadrature, In-phase and Out-of-phase quadrature plots and Quality factor measurement of RLC circuits
- ■ Characterising S-parameters, ABCD and Z matrices of common 2 port networks – coaxial cable, attenuator, low pass high pass bandpass filters etc.
- ■ Characterising 3 port networks – directional couplers, circulators, isolators
  - o Using a spectrum analyser
    - ■ Noise from a resistor at different temperatures

- ● Interfacing instruments with a computer

- ● Data acquisition
  - o Signal demodulation – heterodyne vs Homodyne, Mixing of signals
  - o Sampling, digitisation using ADCs – under-sampling and aliasing, oversampling and noise
  - o Averaging and interpolation techniques
- ● Quantum Simulators
  - o Running quantum protocols in a quantum simulator
  - o Implementing simple quantum algorithms on cloud-based quantum computers (depending on availability of time on such machines)
- ● Running simple algorithms on cloud-based quantum processors (optional)

Course References:

1. Optics, Eugene Hecht, A. R. Ganesan, 5th edition, Pearson (2019)
2. Art of Electronics, Paul Horowitz and Winfield Hill, 3rd edition, Cambridge University Press (2015)
3. Digital Design, Morris Mano, Michael D. Cilletti, 6th edition, Pearson Education (2018)
4. Microwave Engineering, David Pozar, 4th edition, Wiley (2013)
5. Discrete-time signal processing, Alan V. Oppenheim and Ronald W. Shaffer, 4th edition, Pearson (2009)
6. Optical quantum information and quantum communication, A. Pathak and A. Banerjee, SPIE Spotlight Series, SPIE Press (2016)

Similarity Content Declaration with Existing Courses: None

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

Justification for new course proposal if cumulative similarity is >30% : NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair   **School/Center:** CQST

Signature: ………………..   Date: ……………..

⋯⋯⋯
Recommended/Not Recommended, with Comments:

_____   Date: ……………
    Chairman, CPC

Approved/Not Approved

_____   Date: ……………..
    Chairman, Senate

IIT Mandi
Proposal for a New Course

Course Name	: **Introduction to Quantum Computation**
Course Number	: QT 05
Credits	: 2-0-1-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: Students of this course learn (i) To review the basic postulates of quantum mechanics, (ii) The theoretical basics of qubits and their physical realisations, (iii) To work with density operators and time evolution for mixed states, (iv) The basic ideas of quantum gates, (v) The working of important quantum algorithms, (vi) The basics of quantum error correction

Course Content and syllabus:

- Qubits versus classical bits
    - Spin-half systems and photon polarizations
    - Trapped atoms and ions
    - Artificial atoms using circuits
    - Semiconducting quantum dots
    - Single and Two qubit gates – Solovay - Kitaev Theorem
- Quantum correlations
    - Entanglement and Bell's theorems
- Review of Turing machines and classical computational complexity
    - Time and space complexity (P, NP, PSPACE)
- Reversible computation
- Universal quantum logic gates and circuits
- Quantum algorithms
    - Deutsch algorithm
    - Deutsch Josza algorithm
    - Bernstein - Vazirani algorithm
    - Simon's algorithm
- Database search
    - Grover's algorithm
- Quantum Fourier Transform and prime factorization
    - Shor's Algorithm.
- Quantum complexity classes – Q, EQP, BQP, BPP, QMA
- Additional Topics in Quantum Algorithms
    - Variational Quantum Eigensolver (VQE)
    - HHL

- o QAOA
- Introduction to Error correction
  - o Fault-tolerance
  - o Simple error correcting codes
- Survey of current status
  - o NISQ era processors
  - o Quantum advantage claims
  - o Roadmap for future

Course References:

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
2. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
3. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
4. Quantum error correction and Fault tolerant computing, Frank Gaitan, 1st edition, CRC Press (2008)
5. Quantum computing explained, David McMahon, Wiley (2008)
6. Introduction to Quantum Computing: From a lay person to a programmer in 30 steps, Hui Yung Wong, 1st edition, Springer-Nature Switzerland AG (2022)

Similarity Content Declaration with Existing Courses: None

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

Justification for new course proposal if cumulative similarity is >30% : NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair   **School/Center:** CQST

Signature: ....   Date: ....

....

Recommended/Not Recommended, with Comments:

_____
Chairman, CPC

Date: ....

Approved/Not Approved

_____
Chairman, Senate

Date: ....

IIT Mandi
Proposal for a New Course

Course Name	: **Introduction to Quantum Communication**
Course Number	: QT 06
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: *Students of this course learn (i) The basics of EM theory, (ii) The basics of photodetection, (iii) The basics of information theory, (iv) The central ideas in quantum communications*

Course Content and syllabus:

- Basics of Polarization optics
  - Quarter and half-wave plates
  - Polarizing beam splitters
- Basics of linear and square-law detectors
  - Quadrature amplitude modulation
  - Heterodyne and Homodyne demodulation and linear detectors
  - Intensity measurements and square law detectors
  - Photomultipliers, Avalanche Photo diodes
- Digital communication – information theory (basics)
  - Information entropy
  - Noiseless channel encoding
  - Noisy channel encoding
- No cloning theorem
- Quantum Memories
- Quantum repeaters
- Entanglement and Bell Theorems
- Bell Measurements and Tests
- Quantum Teleportation protocol
- Quantum Dense coding
- Quantum Key Distribution protocols
  - BB84
  - E91
  - BBM92.
  - B92
  - COW
  - DPS
- Quantum Networks and Quantum Internet

- Survey of Hardware implementations
  - Free space communications
  - Satellite based communications
  - Fibre optics-based communications

Course References:

1. Quantum computation and quantum information – Nielsen and Chuang Cambridge University Press, Cambridge (2010)
2. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)

Similarity Content Declaration with Existing Courses: None

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

Justification for new course proposal if cumulative similarity is >30% : NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair   **School/Center:** CQST

Signature: ………………..   Date: ……………..

………

Recommended/Not Recommended, with Comments:

                                             Date: …………….

_____
Chairman, CPC

Approved/Not Approved

                                             Date: …………….

_____
Chairman, Senate

IIT Mandi
Proposal for a New Course

Course Name	: **Introduction to Quantum Sensing**
Course Number	: QT 07
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: *Students of this course learn (i) The basics of classical sensing, (ii) Aspects of quantum measurement, (iii) Ways to quantify quantum sensing, (iv) About measurements of quantum states of light, (v) About the applications of quantum sensing*

Course Content and syllabus:

- Classical sensing
  - Photo detection
- Classical noise
  - Johnson Noise, Telegraph noise, flicker or 1/f noise
- Sensitivity of classical measurements
  - Classical Fisher information
  - Cramer - Rao bounds (information theory basics may be required here).
- Quantum measurements
  - projective/orthogonal measurements
  - Approximate/non-orthogonal measurements
  - Weak continuous measurements
  - Error-disturbance relations
  - Standard quantum limits
  - Quantum non-demolition measurements
- States of light
  - Fock states
  - Coherent states
  - Squeezed states
  - Tomography
  - Wigner quasi-probability distribution
  - P-distribution
  - Husimi Q function
- Quantum photo detection
  - Square-law detectors, Intensity measurements and Photo-detection
  - Linear Detectors and Quadrature Measurements
- Quantum Cramer-Rao bounds
- Single photon-based sensing applications

- Entanglement based sensing applications
- Atomic state-based sensing, solid-state spin-based sensing applications (gravimetry, magnetometry)

Course References:
1. Quantum Measurement and Control, Howard Wiseman and David Milburn, Cambridge University Press (2014)
2. Quantum Measurement, Vladimir Braginsky and Farid Ya Khalili, Cambridge University Press (1995)
3. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)

Similarity Content Declaration with Existing Courses: None

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

Justification for new course proposal if cumulative similarity is >30% : NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair   **School/Center:** CQST

Signature: ....   Date: ....

....

Recommended/Not Recommended, with Comments:

                                                                Date: ....

_____
Chairman, CPC

Approved/Not Approved

_____
                                                                Date: ....

Chairman, Senate

IIT Mandi
Proposal for a New Course

Course Name	: **Introduction to Quantum Materials**
Course Number	: QT 08
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: *Students of this course learn (i) The basic idea of quantum materials, (ii) The basics of band theory of solids, (iii) The basics of magnetism, (iv) The basics of superconductivity, (v) About new 2D materials like graphene, TMDCs, (vi) About topology and topological phases of matter*

Course Content and syllabus:

- Band theory basics
    - Metals, Semiconductors and Insulators
    - Band structure of solids
    - Survey of semiconducting devices for quantum technologies (electronic, quantum optical devices and principle of operation)
- Correlated systems
- Magnetism
    - Para, ferro magnetism basics
    - Magnetic measurements, hall effect, magnetoresistance
    - Faraday and Kerr effects
- Superconductivity
    - BCS theory
    - Ginzburg Landau
    - Josephson Effect – AC and DC Josephson effects
    - Survey of superconducting devices for quantum technologies
- 2D materials
    - Graphene and its properties – single and few layers
    - Transition Metal Dichalcogenides – Electronic and Optical Properties
- Topological Phases of matter
    - Basics of Topology
    - Geometric phases - Berry Phase
    - Aharonov Bohm effect
    - Topological phases of matter
- Survey of material growth techniques
    - Molecular beam epitaxy
    - Chemical vapor deposition, MOVPE

- Pulsed laser deposition, etc.
- Crystal growth techniques

Course Outcomes:

Students of this course learn

1. The basic idea of quantum materials
2. The basics of band theory of solids
3. The basics of magnetism
4. The basics of superconductivity
5. About new 2D materials like graphene, TMDCs
6. About topology and topological phases of matter

Course References:

1. Condensed Matter Physics, M P Marder, 2nd Edition, John Wiley and Sons, 2010
2. Introduction to Superconductivity, Michael Tinkham, standard ed., Medtech (2017)

Similarity Content Declaration with Existing Courses: None

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

Justification for new course proposal if cumulative similarity is >30% : NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair   **School/Center:** CQST

Signature: ………………..   Date: ……………..

....

Recommended/Not Recommended, with Comments:

Date: ……………

_____
Chairman, CPC

Approved/Not Approved

Date: ....

_____

Chairman, Senate

IIT Mandi
Proposal for a New Course

Course Name	: **Engineering Foundations of Quantum Technologies**
Course Number	: QT 09
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: This course is meant to cover topics in electrical, electronics and communication engineering, as well as in computer science that are relevant to Quantum computation, Communications and Sensing. This is a survey course and not meant for a rigorous treatment of each topic. Students of this course learn (i) Relevant topics from Electrical Networks to design and analyse analog circuits, (ii) Relevant topics from RF and Microwave Engineering to design systems, (iii) Relevant topics in Theory of computation to benchmark algorithms, (iv) Relevant topics in analog and digital communications, (v) Basics of cryptography

Course Content and syllabus:

- Electrical Networks (4 hours)
    - Analog RLC circuits – resonances, impedances, quality factors
    - Transmission line basics (2 hours)
        - Telegrapher equations, wave impedance, impedance matching, transmission line resonators
- Computer Science (15 hours)
    - Basics of computer architecture (1 hour)
        - Arithmetic Logic Unit
        - Memory
    - Abstract models of computation (12 hours)
        - Finite State Machine
        - Turing Machines
        - Overview of Hierarchy of languages – Regular, Context-Free, Turing Decidable and Turing Recognisable
    - Complexity Theory (2 hours)
        - Time and Space complexity
        - P vs NP, NP-completeness
- Electrical Communications (1 hour)
    - Analog Communications (1 hour)
        - Quadrature amplitude modulation
        - Heterodyne and Homodyne demodulation

- Noise and Signals (6 hours)
  - Characterising Noise
  - Types of Noise
    - Shot Noise
    - Johnson-Nyquist Noise
    - Telegraphic noise or flicker or 1/f noise
  - Signal conditioning and noise mitigation
  - Amplification and Added Noise
    - Linear Amplifier theory
    - Signal-Noise Ratio, Added Noise, Noise Figure of amplification
    - Dynamic Range
    - Noise temperature
    - Quantum limits on noise in linear amplifiers
- Digital Communications (4 hours)
  - Information entropy
  - Noiseless channel encoding
  - Noisy channel encoding
- Basics of cryptography (6 hours)
  - Basics of Number Theory
  - Random Number Generation
  - One time pad, Private key, public key, symmetric and asymmetric cryptography protocols
  - RSA and DH
  - Post Quantum Cryptography (PQC)

Course Outcomes:

Students of this course learn
1. Relevant topics from Electrical Networks to design and analyse analog circuits
2. Relevant topics from RF and Microwave Engineering to design systems
3. Relevant topics in Theory of computation to benchmark algorithms
4. Relevant topics in analog and digital communications
5. Basics of cryptography

Course References:

1. Art of Electronics, Paul Horowitz and Winfield Hill, 3ʳᵈ edition, Cambridge University Press (2015)
2. Digital Design, Morris Mano, Michael D. Cilletti, 6ᵗʰ edition, Pearson Education (2018)
3. Microwave Engineering, David Pozar, 4ᵗʰ edition, Wiley (2013)
4. Information Theory, Robert B. Ash, Dover Publications (2003)
5. Introduction to the Theory of Computation, Michael Sipser, 3ʳᵈ edition, Cengage India Pvt. Ltd. (2014)
6. Protecting Information – From Classical error correction to quantum cryptography, Susan Loepp and William K. Wootters, Cambridge University Press (2006)

Similarity Content Declaration with Existing Courses: None

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

Justification for new course proposal if cumulative similarity is >30% : NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair

School/Center: CQST

Signature: ………………….

Date: ……………..

……….

Recommended/Not Recommended, with Comments:

Date: …………….

_____

Chairman, CPC

Approved/Not Approved

Date: ……………..

_____

Chairman, Senate

IIT Mandi
Proposal for a New Course

Course Name	: **Solid State Physics for Quantum Technologies**
Course Number	: QT 10
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: Students of this course learn (i) Basics of solid states physics, (ii) Various approximations for electronic states in matter, (iii) The theory of phonons in solids, (iv) The theory of magnetism, (v) The theory of superconductivity

Course Content and syllabus:

- Structure of solids –
    - Symmetry, Bravais lattices
    - Laue equations and Bragg's law,
    - Brillouin Zones
    - Atomic scattering and structure factors.
- Characterisation of crystal structures – XRD etc.
- Bonding in solids –
    - van der Waals and Repulsive interactions,
    - Lennard Jones potential,
    - Madelung constant
- The Drude theory of metals –
    - DC & AC electrical conductivity of a metal;
    - Hall effect & magnetoresistance,
    - Density of states, Fermi-Dirac distribution, Specific heat of degenerate electron gases
    - Free electron model
- Beyond the Free electron model
    - Kronig-Penney Model
    - Periodic potential – Bloch Theorem
    - Band theory
    - Tight binding model
- Phonons in Solids
    - One dimensional monoatomic and diatomic chains
    - Normal modes and Phonons
    - Phonon spectrum
    - Long wavelength acoustic phonons and elastic constants
    - Vibrational Properties- normal modes, acoustic and optical phonons.
- Magnetism

- o Dia-, Para-, and Ferromagnetism
- o Langevin's theory of paramagnetism
- o Weiss Molecular theory
- Superconductivity:
  - o Phenomenological description – Zero resistance, Meissner effect
  - o London Theory
  - o BCS theory
  - o Ginzburg-Landau Theory
  - o Type-I and type-II superconductors
  - o Flux quantization
  - o Josephson effect.
  - o High Tc superconductivity

Course References:

1. Introduction to Solid State Physics, Charles Kittel, Wiley India Edition (2019)
2. Condensed Matter Physics, M P Marder, 2nd Edition, John Wiley and Sons (2010)
3. Introduction to Superconductivity, Michael Tinkham, standard edition, Medtech (2017)

Similarity Content Declaration with Existing Courses: None

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

Justification for new course proposal if cumulative similarity is >30% :   NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair   **School/Center:** CQST

Signature: ……………….   Date: ……………..

....

Recommended/Not Recommended, with Comments:

_____

Chairman, CPC

Date: ....

Approved/Not Approved

_____

Chairman, Senate

Date: ....

IIT Mandi
Proposal for a New Course

Course Name	: **Quantum Optics**
Course Number	: QT 11
Credits	: 3-0-0-3
Prerequisites	: Engineering Mathematics (Linear Algebra, Complex algebra, basics of 2nd of ODEs and initial value problems, 2nd order PDEs and boundary value problems, Probability and Statistics, Random variables). Maxwell's equations and EM theory at the level of the core physics syllabus from AICTE model
Curriculum Intended for	: UG/PG/PhD
Distribution	: Elective PG/Elective UG
Semester	: Odd/Even

Preamble: Students of this course learn (i) To quantise the electromagnetic field, (ii) The various experimental techniques in photonics, (iii) The various representations of states of light, (iv) Classical, semi-classical and fully quantum models of light-matter interaction, (v) Modelling decoherence through Master equation

Course Content and syllabus:

- Quantization of the electromagnetic field
  - Number states, coherent states, squeezed states
  - Hanbury-Brown and Twiss experiments – Photon bunching, Photon anti bunching
  - Hong-Ou-Mandel interference
- Theory of Optical coherence
  - Young's double slit experiment and first order coherence
  - Coherence functions of arbitrary order
  - Normal ordering, symmetric ordering and ani-normal ordering of operators
  - Interferometry
- Phase-space representations of states of light
  - Wigner distribution
  - P-function and the notion of non-classicality with some examples of nonclassical states like squeezed states and their applications
  - Husimi Q function
- Light-matter interaction
  - Classical model of light-matter interaction
  - Semi-classical model of light-matter interaction-
  - Quantum light-matter interaction
  - Rabi Model
  - Jayne's-cummings model
- Open quantum systems
  - Fermi golden rule
  - Born-Markov Lindblad Master Equation

Course Outcomes:

Students of this course learn
1. To quantise the electromagnetic field
2. The various experimental techniques in photonics
3. The various representations of states of light
4. Classical, semi-classical and fully quantum models of light-matter interaction
5. Modelling decoherence through Master equation

Course References:

1. Introductory Quantum Optics, Christopher Gerry and Peter Knight, Cambridge University Press (2004)
2. Quantum Optics, D. F. Walls, Gerard J. Milburn, 2nd Edition, Springer (2008)
3. Quantum Optics: An introduction, Mark Fox, Oxford University Publishers (2006)
4. Quantum Optics for Beginners, Z. Ficek and M. R. Wahiddin, 1st edition, Jenny Stanford Publishing (2014)

Similarity Content Declaration with Existing Courses: None

S.N.	Course Code	Similarity Content	Approx. % of content
1.			
2.			

Justification for new course proposal if cumulative similarity is >30% : NA

Approvals:

Other Faculty members interested in teaching this course:

Proposed by: CQST Chair   **School/Center:** CQST

Signature: ....   Date: ....

....

Recommended/Not Recommended, with Comments:

Date: ....

_____
Chairman, CPC

Approved/Not Approved

_____

Date: ....

Chairman, Senate