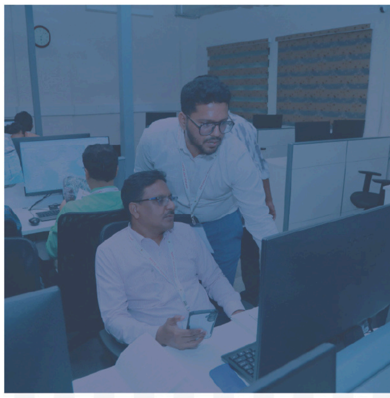
GISAcademia Council of India

2025

Reports of GACI Task Force

Curriculum Template | Training | Interdisciplinary Collaboration



esri India
THE SCIENCE OF WHERE™

Citation Guidelines

When referencing content from this report, please cite it as follows:
GIS Academia Council of India (GACI). (2025). Task Force Reports on Training, Interdisciplinary Collaboration, and Curriculum Template: GIS Academia Council of India.

For citing specific sections or quotes, include the Task Force name and page number, for example:
GIS Academia Council of India (GACI) (2025). Task Force on Interdisciplinary Collaboration, p. 28.

GIS Academia Council of India
gaci@esri.in go.esri.in/gaci +91 120 4694900

Table of Contents

Foreword	i
Messages	ii
Acknowledgements	viii
Report of the GACI Task Force on Curriculum Template	1
Report of the GACI Task Force on Training	31
Report of theTask Force on Interdisciplinary Collaboration	40

Foreword

The rapid evolution of geospatial technologies necessitates that our academic institutions keep pace in imparting technical knowledge to cater to the rising trends in the technology to prepare India's next generation of innovators and problem-solvers. The GIS Academia Council of India (GACI) was founded with a vision: to advance geospatial education, research, and innovation in our country.

When the Council was re-convened last year, it was clear that advancing GIS learning required a structured, consultative approach that addressed foundational gaps, promoted cross-disciplinary engagement, and aligned academic training with the evolving needs of the industry. This conviction led to the creation of three dedicated Task Forces—on Training, Interdisciplinary Collaboration, and the Curriculum Template.

Together, they reflect a strategic approach to align geospatial learning with India's broader skill development and innovation goals. These efforts are designed to create a talent pipeline that is industry-ready, globally competitive, and capable of leading research and innovation in emerging domains.

The release of these three Task Force Reports marks a significant milestone in GACI's journey to strengthen geospatial education and research in India. Each Task Force has worked with dedication, drawing on the collective expertise of academicians and industry leader. Together, these reports form an integrated roadmap to nurture a generation of professionals equipped with both technical competence and the ability to apply geospatial thinking to diverse challenges—from climate resilience and urban planning to public health and disaster management.

GACI's commitment is to build a robust, future-ready geospatial academic ecosystem—one that empowers educators, inspires students, and strengthens the nation's knowledge capital. These recommendations are not just for adoption by academic institutions; they are an invitation to industry to co-create opportunities, to government to enable policy frameworks, and to the global community to collaborate with India's growing geospatial talent pool.

The relevance of this work is both national and global. As the world increasingly depends on location intelligence for sustainable development, India has the opportunity—and responsibility—to lead. I call upon all stakeholders to adopt, and adapt these recommendations, ensuring that the trends in geospatial becomes an integral part of our collective progress.

With these reports, we take a decisive step toward that vision. The journey ahead will demand shared commitment, but the potential rewards—for our students, our institutions, and our society—are boundless.

Dr Shailesh Nayak, *Director National Institute of Advanced Studies and Chair, GIS Academia Council of India (GACI)*

Message

India stands at a pivotal moment in its journey toward becoming a global leader in geospatial innovation. As industries and governments increasingly adopt GIS-driven solutions for decision-making, the demand for a skilled and future-ready workforce has never been greater. This is where the alignment between academic capability and workforce needs becomes critical.

The GIS Academia Council of India (GACI) was envisioned as a platform to close this gap. Our role is to ensure that the skills taught in classrooms reflect the competencies required in professional environments, whether in urban planning, environmental management, disaster resilience, or emerging domains like GeoAI and Digital Twins.

The three Task Force Reports presented here are essential tools for systemic change. They collectively address not just what to teach, but how to teach, who to involve, and why it matters for national growth. Together, they provide a strategic roadmap that can guide institutions in preparing students who are not only employable but also capable of innovation and leadership.

By adopting these recommendations, we have an opportunity to create a truly integrated geospatial ecosystem—one in which academia produces graduates with the knowledge, adaptability, and practical experience to contribute meaningfully. I urge educational institutions to engage deeply with these reports and act decisively on their recommendations.

The future of India's geospatial workforce depends on the choices we make today. With collective commitment, we can ensure that our nation not only meets its own needs but also sets the benchmark for excellence on the global stage.

Prof. Rajiv Gupta*, Senior Professor, Department of Civil Engineering, BITS Pilani and Co-Chair, GIS Academia Council of India (GACI)*

Message

One of GACI's greatest strengths lies in its ability to connect people, ideas, and institutions. In the rapidly evolving world of geospatial technology, no single institution can address the full spectrum of challenges or harness the complete breadth of opportunities. Cross-institutional collaboration is therefore not a choice, but a necessity.

Through its network of universities, research bodies and industry leaders GACI fosters an environment where innovation is nurtured and solutions are co-created. By bringing diverse perspectives together we enable geospatial thinking to extend beyond traditional boundaries. This interdisciplinary and inter - institutional approach is what drives both relevance and impact.

The recommendations presented in the three Task Force Reports are not just blueprints for curriculum or training—they are catalysts for engagement. Their true value will be realised when students, faculty, and research networks actively participate in adopting and adapting these ideas to their unique contexts. Whether through collaborative research projects or joint capacity-building initiatives, the goal is to make geospatial learning a shared and evolving pursuit to cater to the evolving needs.

But our work does not end with the release of these reports. Sustaining momentum requires ongoing dialogue, periodic review of progress, and the willingness to refine strategies in response to emerging needs and technologies. GACI will continue to act as a convener and enabler, ensuring that the partnerships formed today grow stronger and more impactful in the years to come.

Together, we can build a geospatial education ecosystem that is inclusive, forward-looking, and capable of producing knowledge and innovations that benefit not only India, but the global community.

Rajesh C Mathur, *Senior Director - Strategy, ESRI India and*
Co-Chair GIS Academia Council of India (GACI)

Message

The future of every nation rests on its ability to prepare a workforce that is not only skilled in current technologies but is also agile enough to embrace what is yet to come. In the geospatial domain, this means nurturing a generation that can harness location intelligence to drive innovation, enhance governance, and address the most pressing societal challenges of our time.

When Esri India initiated the GIS Academia Council of India (GACI), the intent was clear—to create a platform that enables sustained engagement between academia and industry, ensuring that geospatial education in India evolves in lockstep with technological advancements and real-world demands. The three Task Force Reports presented here are an outcome of that vision—offering actionable strategies to strengthen capacity building, foster interdisciplinary collaboration, and design forward-looking curricula that reflect both foundational rigour and the latest innovations.

India is uniquely positioned to become a global leader in geospatial capability. We have a vibrant academic ecosystem and a rapidly expanding technology sector. But to realise this potential, we must move beyond incremental change and invest in systemic transformation—ensuring that every learner, educator, and institution has the resources and opportunities to excel.

These reports are not just recommendations; they are a roadmap for national progress. They call for adoption, continuous innovation, and collaboration. I invite universities to embrace these frameworks, industry to partner in bringing them to life, and government to enable supportive policies that expand their reach and impact.

At Esri India, we remain committed to supporting this journey—providing world-class technology, fostering knowledge exchange, and building the bridges that connect academic excellence with industry relevance. Together, we can ensure that India's geospatial talent shapes solutions not only for our nation but for the world.

***Agendra Kumar**, Managing Director, Esri India*

Message

A curriculum is more than a list of subjects—it is a roadmap that shapes the way learners think, explore, and solve problems. In the rapidly evolving geospatial domain, where technological change is constant and applications are expanding across every sector, our academic frameworks must be flexible, forward-looking, and responsive to national priorities.

Our guiding principles were clear. First, the curriculum must provide a solid grounding in core GIS knowledge—spatial data concepts, analysis techniques, cartography, and geospatial data management—ensuring students develop strong conceptual and technical foundations. Second, it must integrate emerging trends such as remote sensing advancements, GeoAI, digital twins, UAV applications, and cloud-based GIS, enabling graduates to work with cutting-edge tools and methodologies. Third, it should foster application-oriented learning, encouraging problem-solving through real-world case studies and projects relevant to sectors like urban governance, environmental management, agriculture, and disaster resilience.

Recognising the varied capacities and needs of institutions, the framework was intentionally designed for flexibility. This flexibility is vital for ensuring that institutions, whether well-established or developing, can offer relevant and high-quality geospatial education.

By providing a curriculum template that is both rigorous and adaptable, we aim to ensure that GIS education across India remains relevant, future-focused, and capable of producing graduates and post-graduates who are not only proficient in current technologies but also ready to embrace innovations yet to come. It is our hope that institutions will see this framework as a living document—one that evolves alongside the field and continues to serve as a bridge between education, research, and industry needs.

Dr R P Singh, *Director, IIRS and*
Chair, Task Force on Curriculum Template

Message

The success of our academic system in producing competent, industry-ready geospatial professionals relies fundamentally on the strength of our training programs and capacity-building efforts. The training and capacity-building mechanisms needs to ensure that the curriculum is well-designed to provide an effective blueprint and the training is delivered to with quality assurance in imparting knowledge into skill that demon stares impacts. Recognizing this, the Task Force on Training was established to address both the immediate needs and the long-term strategies for enhancing geospatial competencies nationwide.

Technology is evolving at an unprecedented pace, but its true potential is only unlocked by a set of skilled individuals—educators who can effectively train, and students/trainees who can confidently apply what they've learned to solve real-world problems.

Our task force looked into integrating training in our teaching environments. Teaching focuses on imparting broad theoretical knowledge and conceptual understanding, typically in academic settings. Its goal is to foster critical thinking and intellectual growth, with outcomes measured through traditional assessments like exams and projects. In contrast, training is centered on developing specific, practical skills for a job or activity, using hands-on methods and performance-based assessments to ensure immediate job readiness and increased productivity.

Training our educators for imparting knowledge of rapidly advancing domains of GIS is especially critical. Faculty members act as multipliers, influencing generations of students through their teaching and mentorship. When our educators are equipped with the latest tools and methodologies, they not only improve the quality of instruction but also inspire students to fully explore the potential of GIS in diverse fields.

A key part of this is embracing **activity-based learning**. While this approach is highly beneficial, it requires trainers and teachers to design thoughtful, engaging activities. Our training programs for educators address this directly by encouraging them to use local issues as case studies, making the learning both relevant and impactful.

Our Task Force on Training identified several key gaps hindering progress, including limited access to advanced GIS tools, inconsistent access to high-quality data, a lack of hands-on learning opportunities, and a shortage of structured professional development paths. To address these challenges, we have proposed a framework that balances conceptual learning with practical application, integrates industry engagement, and leverages both physical and digital platforms to reach every corner of the country.

This work highlights the importance of viewing training not as a one-time event, but as a continuous process that evolves alongside technological progress. The recommendations are actionable, scalable, and adaptable to various institutional contexts. I urge academic leaders to embrace these strategies, ensuring our educators are prepared not just for today's opportunities but are ready to lead in shaping the future of geospatial science.

Dr. Khanindra Pathak*, Professor of Mining Engineering and*
Advisor, Centre for Teaching Learning and Virtual Skilling, IIT Kharagpur
Chair of GACI Task Force on Training

Message

The challenges of our time—climate change, sustainable urbanisation, disaster resilience, food security, and public health—are inherently complex. They do not conform to the boundaries of any single discipline. Solving them requires the integration of knowledge, methods, and perspectives from multiple fields. This is where geospatial technology proves invaluable, serving as a common language for scientists, engineers, planners, and policymakers alike.

The Task Force on Interdisciplinary Collaboration was formed to explore how GIS can be positioned as a catalyst for cross-domain innovation in academia. We found cases where civil engineering departments collaborated with environmental sciences on flood modelling, where public health researchers used spatial analytics in disease tracking, and where social sciences partnered with geoinformatics teams to study migration patterns. These successes demonstrate that geospatial tools are most powerful when embedded into broader problem-solving frameworks.

However, such collaborations are often ad-hoc, dependent on individual initiative rather than institutional design. To embed interdisciplinary engagement into academic structures, our recommendations focus on institutional mandates that encourage and reward joint teaching, research, and grant proposals across departments, shared infrastructure, interdisciplinary curriculum modules being co-developed and co-taught by faculty from different disciplines, and research network platforms for collaborative projects.

By normalising interdisciplinary collaboration, we not only enhance the relevance of GIS education but also produce graduates equipped to address multifaceted real-world problems. The goal is to create an academic culture where crossing disciplinary boundaries is not the exception, but the norm—driving innovation and delivering solutions that have tangible societal impact.

Prof. Chander Kumar Singh, *Professor, Department of Environmental Science, Gautam Buddha University, and Chair Task Force on Interdisciplinary Collaboration*

Acknowledgements

The GIS Academia Council of India (GACI) extends its deepest gratitude to all those whose dedication, expertise, and collaborative spirit made these Task Force Reports possible.

We sincerely thank the Task Force Chairs— Prof. R. P. Singh (Curriculum Template), Dr. Khanindra Pathak (Training), and Prof. Chander Kumar Singh (Interdisciplinary Collaboration) —for their leadership, vision, and commitment in guiding the work from concept to completion.

Our heartfelt appreciation goes to all Task Force Members, who devoted their time, knowledge, and energy to shaping the recommendations contained in this report. Your contributions, whether in the form of research, case studies, data analysis, or strategic insights, have been invaluable in creating a framework that reflects both academic rigour and practical applicability.

We acknowledge the contributions of subject-matter experts, reviewers who participated in consultations and whose careful attention to detail, constructive feedback, and commitment to quality helped refine the final publication. Your perspectives have enriched the reports, ensuring they address the diverse needs of India's geospatial education ecosystem.

Finally, we thank Esri India for its unwavering support and for initiating GACI as a platform to bring academia together in advancing geospatial education, research, and innovation in India.

This report is the result of collective effort and shared purpose. We are confident that the outcomes will serve as a valuable resource for educators, researchers, policymakers, and industry leaders in building a future-ready geospatial workforce.

REPORT

TASK FORCE ON CURRICULUM TEMPLATE

01 Curriculum Template

Background

The rapid evolution of GIS technologies has made it critical for universities to adopt flexible and dynamic curricula that not only addresses present-day demands but also anticipate future challenges with additional employment opportunities for students. As the world becomes increasingly data-driven, GIS and related technologies play a pivotal role in solving global issues, from urban planning and climate change mitigation to disaster management and sustainable development. Given this dynamic landscape, the need for a curriculum template that is agile, comprehensive, and aligned with emerging trends has never been more urgent. To meet this, need the Task force on Curriculum Template under the aegis of GIS Academia Council of India (GACI) has been established with an objective to develop a GIS curriculum template that are aligned and reflects the competencies required by today's workforce while also being adaptable to future technological advancements and that serves as a guiding framework for universities.

Objective

- To design and develop a Curricula Template Guidebook for Geospatial education in India that serves as a guiding model for educational institutions. Although, it will not be mandatory to strictly follow the curriculum as defined in this document, it will provide an opportunity to the educational institutions to change or adapt it to suit their needs.

- The modular curriculum template to highlight emerging trends and technological advancements in the Geospatial field, which emphasizes practical applications of GIS to solve real-world challenges and promote interdisciplinary collaboration, ensuring the curriculum is adaptable across various sectors.

Task Force Members

Chair: Dr. R.P. Singh, Director, IIRS

Members
- Dr. Pramod Kumar, Dean (Academics), IIRS
- RAAJ Ramasankaran, Professor, Department of Civil Engineering, Indian Institute of Technology Bombay
- Dr. T.P. Singh, Professor & Director, Symbiosis Institute of Geoinformatics
- Dr. Seema Joshi, Vice President – Academia and Strategic Initiatives, ESRI India

Introduction

Technological disruptions are rapidly transforming the GIS Industry, necessitating a fundamental shift in academic curricula to align with evolving industry demands. Emerging trends such as automation, artificial intelligence, the Internet of Things, big data, and immersive technologies are revolutionizing how GIS data is collected, managed, and analysed. These advancements create new career pathways, requiring professionals equipped with cutting-edge skills to meet workforce demands.

A curriculum to focus on industry-relevant, advanced competencies and reflect current technological trends and anticipate future developments is desirable. It needs to accommodate students from diverse academic streams such as Civil Engg., Computer Science, Geoinformatics, Geomatics, Information Technology, Earth Science, Atmospheric Science, Physical Science, etc. while aligning their skillsets with distinct career roles in the industry.

Based on this, the Task force proposes the following curriculum template.

Curriculum Template for 2-year PG program in M.Tech. in Geospatial Technology/ Geoinformatics

Objective	To build the professional human resource in the field of Geospatial Technology, equipped with IT and information management skills and to cater to the global Geo-Informatics industry requirements.
Duration (In Months)	24
Intake	To be decided by the University/ Institute
Eligibility	Graduate in Engineering or Post-graduate in Science with **basic knowledge in Geoinformatics** from any recognised University/ Institution of National Importance with a minimum of 50% marks or equivalent grade (45% Marks or equivalent grade for Scheduled Caste/ Scheduled Tribe). The eligibility shall be based on UGC/AICTE norms.
Medium of Instruction	English
Pattern	Semester

Assessment	All internal courses will have 100% component as internal evaluation at the institute level. All external courses will have 60% internal component and 40% component as external [University] exam. This shall be based on UGC/AICTE norms.
Standard of Passing	The assessment of the student for each examination is done based on relative performance. Maximum Grade Point (GP) is 10 corresponding to O (outstanding). For all courses, a student is required to pass both internal and external examination separately with a minimum Grade Point of 4 corresponding to Grade P. Students securing less than 40% absolute marks in each head of passing will be declared FAIL. Generally, the Universities awards a degree to the student who has achieved a minimum CGPA of 4 out of maximum of 10 CGPA for the programme. This shall be based on UGC/AICTE norms.

SEMESTER 1

Course Code	Course Title	Credit			Internal Marks	External Marks	Total Marks
		Theory	Lab	Total			
101	Foundation Course	0	0	0	0	0	Letter Grade
102	Modern Remote Sensing	2	2	4	120	80	200
103	Advanced Geospatial Analysis & Modelling	1	1	2	60	40	100
104	Principles of DMS, Data Standardization & Managing Geodatabases	1	1	2	60	40	100
105	Python for Geospatial Technology	2	1	3	90	60	150

Course Code	Course Title	Credit			Internal Marks	External Marks	Total Marks
		Theory	Lab	Total			
106	Essentials of Internet and Web Technologies	2	0	2	100	0	100
107	Standalone, Web, Mobile & Cloud GIS Technologies	2	1	3	60	40	100
108	Cyber Security	2	0	2	60	40	100
109	Technical Writing and Research Methodology	2	0	2	100	0	100
110	Geospatial Tech Soln – Architecture, Design, Deployment Patterns	1	1	2	100	0	100
111	Flexi-Credit Course	2	0	2	100	0	100
	Total	**17**	**7**	**24**	**850**	**300**	**1150**
SEMESTER 2							
Course Code	Course Title	Credit			Internal Marks	External Marks	Total Marks
		Theory	Lab	Total			
201	Advance Python Programming for Spatial Analytics	2	1	3	90	60	150
202	Advance Spatial Data Sciences & Big Data Analytics	2	1	3	120	80	200

Course Code	Course Title	Credit			Internal Marks	External Marks	Total Marks
		Theory	Lab	Total			
203	Using GeoAI for Analytics	2	1	3	60	40	100
204	Video Analytics & Real-time GIS	1	1	2			
205	Digital Twins & 3D GIS Modelling	1	1	2	60	40	100
206	UAVs, Drones, AR & VR	1	1	3	90	60	150
207	Geospatial Data Integration with IoT & Block chain	2	1	3	90	60	150
308	GIS Project Lifecycle & Best Practices	2	0	2	100	0	100
209	Flexi-Credit Course	2	0	2	100	0	100
210	Elective 1 (out of 4 Elective)*	1	1	2	100	0	100
	Total	**16**	**8**	**24**	**810**	**340**	**1150**
SEMESTER 3							
Course Code	Course Title	Credit			Internal Marks	External Marks	Total Marks
		Theory	Lab	Total			
301	Project - Phase 1 Research/Industry	0	16	16	600	400	1000
	Total	**0**	**16**	**16**	**600**	**400**	**1000**

SEMESTER 4							
401	Project- Phase 2 Research/Industry	0	16	16	600	400	1000
	Total	**0**	**16**	**16**	**600**	**400**	**1000**

*Institution can increase or decrease elective(s) as per their policy/guidelines

Curriculum Template for 4-year UG program in B.E./B.Tech.

The proposed course curriculum and course credit structure is based on a semester system where each course is assigned a specific number of credits depending on the amount of instruction time per week, meaning a course with more lecture hours will generally have more credits; students earn credits by successfully completing courses throughout their studies, with a minimum number of credits required to graduate.

Objective	To create the prequalification for professional human resource in the field of Geospatial Technology; equipped with IT and information management skills.
Duration (In Months)	48
Intake	To be decided by the University/ Institute
Eligibility	Passed Standard XII (10+2) with any one of the following subjects Mathematics, Statistics, Computer Science, Geology, Earth Science, or equivalent government-approved diploma in Engineering/ Technology from any recognized Board with a minimum of 45% marks or equivalent grade (40% marks or equivalent). The eligibility shall be based on UGC/AICTE norms.
Medium of Instruction	English
Pattern	Semester
Assessment	All internal courses will have 100% component as internal evaluation at the institute level. All external courses will have 40% internal component and 60% component as external [University] exam. This shall be based on UGC/AICTE norms.

Standard of Passing	The assessment of the student for each examination is done based on relative performance. Maximum Grade Point (GP) is 10 corresponding to O (outstanding). For all courses, a student is required to pass both internal and external examination separately with a minimum Grade Point of 4 corresponding to Grade P. Students securing less than 40% absolute marks in each head of passing will be declared FAIL The University awards a degree to the student who has achieved a minimum CGPA of 4 out of 10. This shall be based on UGC/AICTE norms.

Course Credit Structure

In general, a certain quantum of academic work measured in terms of credits is laid down as the requirement for a particular degree. A student earns credits by satisfactorily clearing courses/ other academic activities every semester. The credits associated with a course/ other academic activity are dependent on the number of hours of work expected to be put in by the student per week. A semester is typically considered as 15-16 weeks of instruction.

Theory and Laboratory Courses

Courses are broadly classified as Theory Courses and Laboratory Courses. Theory courses consist of lecture (L) and tutorial (T) hours, and they will have attached practical (P) hours wherever required. Laboratory courses consist of practical hours, but may have attached tutorial hours in special cases. Credit (C) for a course is obtained by multiplying the number of hours of instruction per week in that course as follows.

NEP 2020 Credit Calculation Formula
1 Credit = 1 Hour of Lecture/Tutorial per Week over a Semester
OR
1 Credit = 2 Hours of Practical/Studio/Field Work per Week over a Semester

Two examples of credit calculation are shown below:

Theory Course				**Laboratory Course**			
L	T	P	**C**	L	T	P	**C**
2	1	0	**3**	0	1	3	**2.5**

Laboratory Integrated Theory			
L	T	P	**C**
2	0	2	**3**

Projects

University/Institute can prescribe Project as a requirement for the B.E/B.Tech. degree under the guidance of a faculty member, wherein a student, in the sixth semester or later, is required to do innovative work with the application of knowledge gained from courses in the earlier years. The student is expected to do a survey of literature in the subject, work out a project plan and carry it out through design, analysis, experimentation, etc. These projects i.e., Bachelor of Technology Project (BTPs) may be offered as a single unit of 12 credits (BTP) or as 6 credits of BTP-I followed by BTP-II of 6 credits or 12 credits.

Course Type:

- **LIT –** Laboratory Integrated Theory
- **T –** Theory
- **L –** Laboratory Course
- **BTP –** B.E/B.Tech. Project (BTP-1 and BTP-II)

Minimum Credit Requirements

The minimum credits required for the award of a B.E./B.Tech. degree shall be between 140 and 150. This is nominally divided into different course categories as follows:

- Basic Sciences (15-18)
- Engineering Sciences & skills (12-15)
- Humanities and Social Sciences (HSS), Economics and Finance Electives (8-10)
- Institute Electives (6-8)
- Departmental Courses including Program Electives (95 - 100).
- Internship & Field Camp Courses (3-7)

Program electives (PE) are categorized into 6 verticals. Students can choose electives from any verticals of their choice or can choose from one focused vertical to get a B.E./B.Tech. Degree with a mentioning of that focus area on their degree certificate.

Example: B.E. Geoinformatics with focus in Geo-Intelligence

A typical course load for a B.E./B.Tech. student shall be 17-21 credits. It usually consists of four to five theory courses and 1-2 laboratory courses per semester which are considered the "normal" load, with the option to take additional electives or honours courses depending on the department and student's academic goals; this is based on a credit-based system where each course is assigned a certain number of credits.

Overview of Credit Structure

Semester	Basic Sciences (BS)	Engineering Sciences & Skills (ESS)	HSS, Economics and Finance (HEF)	Instt. Electiveor Instt. Core (IE)/(IC)	Dept Core (DC)	Prog Electives (PE)	Internships/ Field camp (IN)	Credit (C)
I	7.5	9	3	-	-	-	-	19.5
II	9	4	3.5	-	3	-	-	19.5
III	-	-	2.5	-	15	-	-	17.5
IV	-	-	-	-	18	-	1.5	19.5
V	-	-	-	3	13.5	3	-	19.5
VI	-	-	-	3	12	3	1.5	19.5
VII	-	-	-	-	12	3	-	15
VIII	-	-	-	-	3	12	-	15
Total	**16.5**	**13**	**9**	**6**	**76.5**	**21**	**3**	**145**

SEMESTER - 1				
S. No.	**Course Name**	**Course Category**	**Credit Structure L- T- P- C**	**Remarks**
1	Foundation English	HEF	2-0-2-3	-
2	Matrices and Calculus	BS	2-1-0-3	-
3	Engineering Physics	BS	3-0-0-3	-

S. No.	Course Name	Course Category	Credit Structure L- T- P- C	Remarks
4	Engineering Drawing & 3D Modelling	ESS	2-0-2-3	-
5	Fundamentals of Electrical and Electronics Engineering	ESS	2-0-2-3	-
6	Computer Programming-I	ESS	2-0-2-3	-
7	Engineering Physics Lab	BS	0-0-3-1.5	-
8	NCC/NSS/NSO	IC	0-0-2-NP/P	-
9	Gender in the Workplace	IC	NP/P	-
Total Credits			**19.5**	
		SEMESTER - 2		
S. No.	**Course Name**	**Course Category**	**Credit Structure L- T- P- C**	**Remarks**
1	Professional Communication	HEF	1-0-2-2	-
2	Ordinary Differential Equations and Transform Techniques	BS	2-1-0-3	-
3	Engineering Chemistry	BS	2-0-2-3	-
4	Biology for Engineers	BS	2-1-0-3	-
5	Principles and Applications of Electromagnetic radiation in Remote Sensing	DC	2-1-0-3	-
6	Computer Programming -II	ESS	2-0-2-3	-

S. No.	Course Name	Course Category	Credit Structure L- T- P- C	Remarks
7	Makers Space	ESS	0-0-2-1	-
8	Professional & Ethics and Universal Human values	HEF	1-0-1-1.5	-
Total Credits			**19.5**	
		SEMESTER - 3		
S. No.	Course Name	Course Category	Credit Structure L- T- P- C	Remarks
1	Probabilistic and Statistical Methods for Geospatial Engineers	DC	2-1-0-3	-
2	Economics for Engineers	HEF	2-0-1-2.5	-
3	Coordinate Systems, Map Projections and Cartography	DC	2-1-0-3	-
4	Environmental Sciences, Engineering and Management	DC	2-1-0-3	-
5	Remote Sensing Technology	DC	2-1-0-3	-
6	Remote Sensing Lab	DC	0-0-3-1.5	-
7	GIS Lab/ Cartography Lab	DC	0-0-3-1.5	-
Total Credits			**17.5**	

SEMESTER - 4				
S. No.	**Course Name**	**Course Category**	**Credit Structure L- T- P- C**	**Remarks**
1	Artificial Intelligence & Data Science	DC	2-0-2-3	-
2	Numerical Methods and Computation	DC	2-1-0-3	-
3	Elementary Engineering Surveying	DC	2-1-0-3	-
4	Engineering Surveying Lab	DC	0-0-3-1.5	-
5	Fundamentals of Geographical Information Systems (GIS)	DC	2-0-2-3	-
6	Digital Image Processing (DIP) of Remotely Sensed Images	DC	2-1-0-3	-
7	DIP Lab	DC	0-0-3-1.5	-
8	Survey Camp	IN	1.5	5 days camp during winter break
Total Credits			**19.5**	

SEMESTER - 5				
S. No.	**Course Name**	**Course Category**	**Credit Structure L- T- P- C**	**Remarks**
1	Design Thinking for Innovation/Any other course	IE	2-0-2-3	-
2	Principles of Photogrammetry	DC	2-1-0-3	-

3	Spatial Databases and Database Management Systems	DC	2-0-2-3	-
4	Geodesy Basics	DC	2-1-0-3	-
5	Dept. Elective -I	PE	3	-
6	IoT Basics	DC	2-0-2-3	-
7	Photogrammetry Lab	DC	0-0-3-1.5	-
Total Credits			**19.5**	
		SEMESTER - 6		
S. No.	**Course Name**	**Course Category**	**Credit Structure L- T- P- C**	**Remarks**
1	Advanced Surveying	DC	2-0-2-3	-
2	Advanced GIS	DC	2-0-2-3	-
3	Microwave Remote Sensing	DC	2-0-2-3	-
4	LiDAR Surveying: Principles and Applications	DC	2-0-2-3	-
5	Dept. Elective-II	PE	3	-
6	Institute Elective-II	IE	3	-
7	Industry/Academic Internship	IN	1.5	Duration: 1.5 months during summer break
Total Credits			**19.5**	

SEMESTER - 7				
S. No.	**Course Name**	**Course Category**	**Credit Structure L- T- P- C**	**Remarks**
1	Adjustments and Computations for Geospatial Analysis	DC	2-1-0-3	-
2	Hyperspectral and Thermal Remote Sensing	DC	2-0-2-3	-
3	Computer Architecture and Graphics	DC	2-0-2-3	-
4	Introduction to Atmosphere, Hydrosphere, Biosphere and Cryosphere	DC	3-0-0-3	-
5	Dept. Elective-III	PE	3	-
Total Credits			**15**	

SEMESTER - 8				
S. No.	**Course Name**	**Course Category**	**Credit Structure L- T- P- C**	**Remarks**
1	Geo-Intelligence	DC	2-1-0-3	-
2	Dept. Elective-IV	PE	3	-
3	Dept. Elective -V	PE	3	-
4	Dept. Elective -VI	PE	3	-
5	Dept. Elective -VII	PE	3	-
Total Credits			**15**	

Probable List of Program Electives under Different Verticals (Focus Areas)					
VERTICAL I (Surveying & Mapping)	**VERTICAL II (Geospatial Data Analytics)**	**VERTICAL III (Image Processing & Analysis)**	**VERTICAL IV (Geospatial Application)**	**VERTICAL V (Geodesy)**	**VERTICAL VI (Geo-Intelligence)**
Terrestrial and Satellite Photogram metry	GIS Customiza-tion and Scripting	Passive Microwave Remote Sensing and Applications	Environment Geoinfor-matics	Advanced Geodesy	Digital Twins & BIM
GNSS Surveying	Location Based Geospatial Services	SAR Polarimetry &Interferom etry	Transport Geoinfor-matics	Fundamen-tals of Gravimetry	Big Data Analytics for Geomatics
Terrestrial and Bathymetric Laser Scanning	GIS data standards, Interoper-ability, Space syntax	Pattern Recognition	Geoinfor-matics for Hydrology and Water Resources	Geodetic Interferome try	IoT Applications in Geomatics
UAS for Large Scale mapping	GIS based Utility and Asset Management	AI/ML in Remote Sensing	Geoinformati cs for Disaster and Risk Mitigation	Geodetic Control Survey and Adjustments	Spatial Decision Support Systems (SDSS)
Underground and Hydrographic Surveying	Geospatial Modelling& Simulation	Agriculture and Forest Management using Geoinfo	Satellite Meteorology	Geodetic Astronomy	Location Intelligence & Surveillance
Cadastral Surveying	Geomatics for SDGs	Imaging Spectro-scopy	Geoinformat ics for Ocean and Coastal Applications	Gravimetry for Environme-ntal Sensing	Cloud Computing and Web GIS
BTP-I/II are considered as PE. (can be registered only during 7th and/or 8th Semesters)					

Curriculum Template for Master of Science (MSc)

Objective	To create the professional human resource in the field of Geospatial Technology; equipped with IT and information management skills to cater to the global Geo-informatics industry requirements.
Duration (In Months)	24
Intake	To be decided by the University/ Institute
Eligibility	Graduate in Engineering, IT, Science, Computer Science, Agriculture, Geography, Planning, Architecture, Commerce and Management from any recognised University/ Institution of National Importance with a minimum of 50% marks or equivalent grade (45% Marks or equivalent grade for Scheduled Caste/ Scheduled Tribes). The eligibility shall be based on UGC/AICTE norms.
Medium of Instruction	English
Pattern	Semester
Assessment	All internal courses will have 100% component as internal evaluation at the institute level. All external courses will have 60% internal component and 40% component as external [University] exam. This shall be based on UGC/AICTE norms.
Standard of Passing	The assessment of the student for each examination is done based on relative performance. Maximum Grade Point (GP) is 10 corresponding to O (outstanding). For all courses, a student is required to pass both internal and external examination separately with a minimum Grade Point of 4 corresponding to Grade P. Students securing less than 40% absolute marks in each head of passing will be declared FAIL The University awards a degree to the student who has achieved a minimum CGPA of 4 out of maximum of 10 CGPA for the programme. This shall be based on UGC/AICTE norms.

SEMESTER 1							
Course Code	Course Title	Credit			Internal Marks	External Marks	Total Marks
		Theory	Lab	Total			
101	Principles of GIS	2	2	4	120	80	200
102	Principles of Remote Sensing	2	2	4	120	80	200
103	Applied Statistics	2	0	2	60	40	100
104	Python for Geospatial Technology	2	1	3	90	60	150
105	Logic Development and Programming Concepts	2	0	2	60	40	100
106	Research Methodology in GIS	2	0	2	100	0	100
107	Global Navigation Satellite System	2	1	3	90	60	150
Total		**14**	**6**	**20**	**640**	**360**	**1000**
SEMESTER 2							
Course Code	Course Title	Credit			Internal Marks	External Marks	Total Marks
		Theory	Lab	Total			
201	Geo Image Processing	2	1	3	90	60	150
202	Photogrammetry	1	1	2	60	40	100

203	Advance Python Programming for Spatial Analytics	2	1	3	90	60	150
204	Essentials of Internet and Web Technologies	2	0	2	100	0	100
205	Principles of Database Management System	1	1	2	60	40	100
206	Spatial Analysis	1	1	2	60	40	100
307	Spatial Data Base Management	2	0	2	60	40	100
208	Machine Learning for Remote Sensing	1	1	2	60	40	100
209	Flexi-Credit Course	2	0	2	100	0	100
Total		**14**	**6**	**20**	**680**	**320**	**1000**

SEMESTER 3							
Cours e Code	**Course Title**	**Credit**			**Internal Marks**	**External Marks**	**Total Marks**
		Theory	**Lab**	**Tota l**			
301	Summer Project	0	8	8	240	160	400
302	GIS Application Design	1	1	2	100	0	100
303	Spatial Big Data and Storage Analytics	1	1	2	60	40	100
304	Citizen Science and Geospatial Technolog	1	1	2	100	0	100

305	Business Communication	2	0	2	100	0	100
306	Spatial Modeling	1	1	2	60	40	100
307	Artificial Intelligence	1	1	2	60	40	100
308	Web GIS	1	1	2	60	40	100
309	Flexi-Credit Course	2	0	2	60	40	100
Total		**10**	**14**	**24**	**840**	**360**	**1200**
Elective Courses (Select any TWO)							
310	Mobile GIS	1	1	2	100	0	100
311	Geoinformatics Applications in Natural Resource Management	1	1	2	100	0	100
312	Geoinformatics applications in Facility and Utility management	1	1	2	100	0	100
313	Geospatial Application in Agriculture	1	1	2	100	0	100
314	Application of Geospatial Technology in Urban Development	1	1	2	100	0	100
315	Disaster Scenario mapping	1	1	2	100	0	100
Elective-Total		**2**	**2**	**4**	**200**	**0**	**200**
Total		**12**	**16**	**28**	**1040**	**360**	**1400**

SEMESTER 4							
401	Industry Project	12			360	240	600
Total		**12**			**360**	**240**	**600**

Curriculum Template for Bachelor of Science (BSc)

Objective	To create the prequalification for professional human resource in the field of Geospatial Technology; equipped with IT and information management skills.
Duration (In Months)	48
Intake	To be decided by the University/ Institute
Eligibility	Passed Standard XII (10+2) with any one of the following subjects Mathematics, Statistics, Computer Science, Geography, Geology, Earth science, or equivalent government-approved diploma in Engineering/ Technology from any recognized Board with a minimum of 45% marks or equivalent grade (40% marks or equivalent). The eligibility shall be based on UGC/AICTE norms.
Medium of Instruction	English
Pattern	Semester
Assessment	All internal courses will have 100% component as internal evaluation at the institute level. All external courses will have 40% internal component and 60% component as external [University] exam. This shall be based on UGC/AICTE norms.
Standard of Passing	The assessment of the student for each examination is done based on relative performance. Maximum Grade Point (GP) is 10 corresponding to O (outstanding). For all courses, a student is required to pass both internal and external examination separately with a minimum Grade Point of 4 corresponding to Grade P. Students securing less than 40% absolute marks in each head of passing will be declared FAIL The University awards a degree to the student who has achieved a minimum CGPA of 4 out of 10. This shall be based on UGC/AICTE norms.

SEMESTER 1					
Course Code	**Course Title**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
101	Basics of Remote sensing	2	20	30	50
102	Introduction to Earth Sciences & Geography	3	30	45	75
103	Introduction to Ecology, Environment & Climate Science	3	30	45	75
104	Essentials of web technology & Network Management	3	30	45	75
105	Applied Statistics I	2	20	30	50
106	Introduction to Programming	3	75	0	75
107	Fundamentals of Database Management System	2	20	30	50
Total		**18**	**225**	**225**	**450**
SEMESTER 2					
Course Code	**Course Title**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
201	Introduction to Python	3	30	45	75
202	Introduction to Java Script	3	30	45	75
203	Linear Algebra	3	75	0	75

204	R Programming	3	30	45	75
205	Applied Statistics II	2	20	30	50
206	Relational database management system	3	75	0	75
207	System Architectures & Design Methodologies	3	30	45	75
Total		**20**	**290**	**210**	**500**
SEMESTER 3					
Course Code	**Course Title**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
301	Advance Remote Sensing	2	20	30	50
303	Geographical Information System	4	40	60	100
304	Spatial Analysis Techniques & Modelling	4	40	60	100
305	Python for Geospatial Data Analysis	2	40	60	100
306	Geostatistics & Spatial Data Sciences	3	30	45	75
307	Flexi Credit Course	3	75	0	75
Total		**18**	**245**	**255**	**500**

SEMESTER 4					
Course Code	**Course Title**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
401	Spatial Database Management Systems	4	100	0	100
402	Standalone, Web, Mobile & Cloud GIS	4	40	60	100
403	Spatial Data Standardization & OGC	3	30	45	75
404	Digital Image Processing	3	30	45	75
405	Cyber Security	2	20	30	50
406	Flexi-Credit Course	4	100	0	100
Total		**20**	**320**	**180**	**500**

SEMESTER 5					
Course Code	**Course Title**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
501	Applications of Geospatial Technologies	4	40	60	100
502	Emerging Trends in Geospatial Technology	4	100	0	100
503	Global Navigation Satellite System/ Drones/ IoT & Sensors Integration	4	40	60	100

504	Intro to AI/ML and Deep Learning Techniques	4	40	60	100
505	Flexi-Credit Course	4	40	60	100
Total		**20**	**260**	**240**	**500**
SEMESTER 6					
Course Code	**Course Title**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
601	GIS Tools & Available Technologies	4	40	60	100
602	GIS Data – Open Sources & APIs Integration	4	40	60	100
603	Project	4	100	0	100
604	Research Methodology	2	20	30	50
605	Flexi-Credit Course	2	50	0	50
606	Organization Behaviour	2	50	0	50
Sub- Total		**20**	**300**	**150**	**450**
Generic Elective Courses Group 1					
606	Creative Writing	2	20	30	50
607	Understanding Cinema	2	20	30	50
608	Fitness for Life	2	20	30	50
609	Music in Media I	2	20	30	50
Sub- Total		**2**	**20**	**30**	**50**

SEMESTER 7					
Course Code	**Course Title**	**Credit**	**Internal Marks**	**External Marks**	**Total Marks**
701	GIS Application Design Considerations	4	40	60	100
702	Geospatial Technology for Human Settlements & Infrastructure Dev	4	40	60	100
703	Geospatial Technology for Water and Natural Resource Management	4	40	60	100
704	Geospatial Technology for Agriculture	4	40	60	100
705	Geospatial technology for Utility Management	4	40	60	100
706	Geospatial technology for Mobility & Transportation	2	20	30	50
707	Research Paper writing	1	25	0	25
708	Business Communication	1	25		25
Total		**24**	**270**	**330**	**600**
Semester 8					
801	Research & Dissertation - Industry Engagement	12	120	180	300
802	Flexi Credit Course	4	40	60	100
Total		**16**	**160**	**240**	**400**

Credit Summary	
Semester	**Total Credits**
Semester1	18
Semester2	20
Semester3	18
Semester4	20
Semester5	20
Semester6	24
Semester7	24
Semester8	16
Total Credits	**160**

Curriculum Template for Postgraduate Diploma in Remote Sensing & GIS

The proposed course curriculum and course credit structure is based on semester system where each course is assigned a specific number of credits depending on the amount of instruction time per week.

Objective	To build the professional human resource in the field of Geospatial Technology, equipped with IT and information management skills and to cater to the global Geo-Informatics industry requirements.
Duration (In Months)	12
Intake	To be decided by the University/ Institute

Eligibility	Graduate in Engineering/Science/Arts in any discipline with basic knowledge in Geoinformatics from any recognised University/ Institution of National Importance with a minimum of 50% marks or equivalent grade (45% Marks or equivalent grade for Scheduled Caste/ Scheduled Tribe). The eligibility shall be based on standard norms.
Medium of Instruction	English
Pattern	Semester
Assessment	This shall be based on UGC/AICTE norms.
Standard of Passing	The assessment of the student for each examination is done based on relative performance. Maximum Grade Point (GP) is 10 corresponding to O (outstanding). A student is required to pass with a minimum Grade Point of 4 corresponding to Grade P. This shall be based on standard norms.

SEMESTER-I (MODULE - 1)					
Paper	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Exam**	**Total**
	Credit/ Hours	**Credit/ Hours**	**Credit/ Hours**	**Hours**	**Credits /Hours**
Paper 1.1: Fundamentals of Remote Sensing (FRS)	2/30	1/15	1/30	6	4/81
Paper 1.2: Digital Image Processing (DIP)	2/30	1/15	1/30	6	4/81
Paper 1.3: Geoinformatics	2/30	1/15	1/30	6	4/81
Paper 1.4: Statistics and Programming for Geodata Analysis	2/30	1/15	1/30	6	4/81
Seminar/ Guest Lecture/ Field work	-	-	-/30	3	0/33
Total	**8/120**	**4/60**	**4/150**	**27**	**16/357**

SEMESTER- 2 (MODULE - 2 and MODULE - 3)						
Paper		Lecture (L)	Tutorial (T)	Practical (P)	Exam	Total
		Credit/ Hours	Credit/ Hours	Credit/ Hours	Hours	Credits /Hours
Paper 2.1: Advances in Remote Sensing (ARS)		2/30	1/15	1/45	6	4/81
Paper 2.2 & 2.3 (Elective)*	2.2	2/30	1/15	1/45	6	4/81
	2.3	2/30	1/15	1/45	6	4/81
Paper 2.4: Natural Resources & Environment Management (NREM)		2/30	1/15	1/45	6	4/81
Seminar/ Guest Lecture/ Field work		-	-	-/30	3	0/33
Total		**8/120**	**4/60**	**4/150**	**24**	**16/357**
Pilot Project						**8/240**
Total						**40/954**

Theory 1 Credit=15 hours; Practical 1 Credit=30 hours; Seminar & Guest Lectures=30 hours

***Electives in Module-3** Geospatial Applications in:			
Code	**Paper 2.2**	**Code**	**Paper 2.3**
2.2a	Agricultural & Crop Modelling (ACM)	2.3a	Forest & Ecosystem Analysis (FEA)
2.2b	Hydrology & Water Management (H&WM)	2.3b	Urban & Regional Studies (URS)

2.2c	Marine & Oceanography (M&O)	2.3c	Meteorology & Atmospheric Sciences (ASM)
2.2d	Geosciences (G)	2.3d	Natural Hazards & Disaster Risk Reduction (NHDRR)
2.2e	Advanced Image Analysis (AIA)	2.3e	Advanced Geoinformatics (AG)

Note:
1. *Elective Paper Module-2: Any two electives to be chosen (One each from elective basket 2.2 and 2.3).*
2. *Universities/ Institutes can offer the electives depending upon the expertise of faculty available.*

Course Contents for Elective on “Overview of Geospatial Technology & Applications”

(Contents are the part of Model Curriculum for **Minor Degree in Space Technology on Space Data Products and Services** and approved by AICTE)
(https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final%20Document%20-%20Space%20Curriculum.pdf)

4 credits

Prerequisites:
Graduate in Arts, Science or Engineering

Course Objectives
To familiarize students with
- Concepts of Remote Sensing & Image Interpretation
- Fundamentals of Digital Image Processing
- Geographical Information System and GNSS
- Data Processing and Terrestrial Applications

Course Contents:
Unit-I: Remote Sensing & Image Interpretation
Definition and Overview of Remote Sensing and Remote Sensing Systems: Electromagnetic Radiation, Laws of Radiation, EM Spectrum, Sources of EMR, Interaction between EM Radiation and matter, Reflection, Absorption and Transmission, Interactions between EM Radiation and Atmosphere, Atmospheric windows. Platforms: Types of platforms (Ground, Airborne and Space borne); Orbit of satellites; Kepler’s law; Satellite characteristics; Satellites for earth observation studies and planetary missions (Chandrayaan); Geostationary and UAV platforms. Sensors: Types and classification; Sensor resolutions. Microwave and Thermal remote sensing: Principles and data characteristics Spectral signatures and Image interpretation: Spectral signatures for common land use/land cover (LULC) classes; Principles of visual image interpretation.

Unit-II: Fundamentals of Digital Image Processing
Remote Sensing Images: Histogram, Image Statistics, Image Display, Colour cube, Look-up-table, Colour Composites, FCC generation. Image Correction: Fundamentals of Image

Rectification and Registration, Spatial Interpolation, Intensity Interpolation (Nearest Neighbour, Bilinear Interpolation, Cubic Convolution), Radiometric Corrections. Image Enhancement: Contrast Enhancement (Linear and Non-linear); Spatial Enhancement: Noise and Spatial filters. Image Transformations: Principal Component Analysis; Image Fusion; Spectral Indices. Image Classification: Principle of Image Classification (Supervised and Un-supervised) and Accuracy Assessment. Advanced Classification Techniques: Image Segmentation, Object based Classification, Image Textures.

Unit-III: Fundamentals of Photogrammetry and GNSS
Concepts of Photogrammetry: Overview of Aerial, Satellite & UAV Photogrammetry; Aerial cameras; Satellite stereo sensors; Types of Photographs; Geometry and scales of Aerial Photographs. Stereo Photogrammetry: Relief displacement, relation with different parameters and vertical exaggeration; Concept of Parallax; Ground height estimation from Parallax. Digital Elevation Model: Digital Terrain Model, DEM, Digital Surface Model, nDSM, bare earth DEM, Structures of DTM, DEM interpolation techniques, derivatives and 3D visualisation, Ortho-photo. Basics of Geodesy: Concepts of land Surveying; Types of maps; Map projections; Concepts of vertical/ horizontal datum (MSL, Geoid, spheroid, WGS-84). Satellite Navigation and Augmentation systems: Principles and components of GNSS, Data collection methods, Differential Global Positioning System (DGPS), Errors in observations and corrections; Overview of GAGAN, IRNSS (NavIC); GNSS reflectometry applications.

Unit-IV: Geographical Information System (GIS)
Introduction to GIS: GIS Components, Data formats and structures. Spatial and Non-spatial data models: Raster and Vector Data Models. Overview of DBMS: Database Design using RDBMS; Spatial and Non-spatial queries. Spatial Data Analysis: Raster and Vector analysis, Buffer, Overlay, etc. Network Analysis and Spatial Interpolation Techniques; Geo-data visualization and analysis: Open-source tools and location-based services.

Unit-V: Data Processing and Dissemination techniques
Big Geo-data: Concepts (5 V's) Artificial Intelligence and Machine Learning: Supervised, Semi-Supervised, Un-supervised and Reinforcement Learning. Deep Learning: CNN, RNN based models. Cloud Based Platforms: Earth Engine, Data Cube, Analysis Ready Data. Geo-Portals: Sources and Geocomputation. Data Analytics: Multidimensional data analytics & visualisation.

Unit-VI: Terrestrial Applications of RS and GIS
Water Resources Assessment and Monitoring: Forestry and Ecology Studies, Climate Change Studies, Agriculture and Soils Studies, Geosciences. Ocean and Atmospheric Applications of RS and GIS: Marine Biology, Coastal Processes, Physical Oceanography, Satellite Meteorology. Space and Planetary Exploration: Major processes affecting Planetary Systems; Overview of remote sensing-based observations of planetary surface from recent missions with emphasis on Indian Planetary Missions Lunar and Martian Geology

Course Outcomes: Students will be able to:
- Discuss Concepts of Remote Sensing & Image Interpretation
- Apply Fundamentals of Digital Image Processing
- Explain Geographical Information System and GNSS
- Describe Data Processing and Terrestrial Applications

REPORT

TASK FORCE ON TRAINING

02

Training

Background

The advancements in GIS technology and its increasing applications across diverse sectors demand that GIS academicians stay current with the latest tools, trends, and methodologies. This will also ensure that the next generation of professionals is well-prepared. However, without structured and ongoing professional development opportunities, many educators face challenges in keeping up with industry changes. To meet this need, the GIS Academic Council of India (GACI) has initiated a Task Force on Training focusing on **"Train the Trainers"** with an objective to address the need for upskilling and reskilling academicians by designing and implementing specialized training programs. Through focused capacity-building initiatives, the task force aims to ensure that the academicians are equipped with cutting-edge knowledge and tools to provide students with a high-quality GIS education that aligns with current and future user needs.

Objective

- To develop and deliver training programs, workshops, and capacity-building initiatives that equip GIS academicians with the latest skills, knowledge, and best practices in the field.

- To create a robust ecosystem of trained educators capable of delivering high-quality GIS education that aligns with current needs and future workforce requirements.

Task Force Members

Chair: Dr Khanindra Pathak, Professor & Head - Department of Mining & Engineering, IIT-Kharagpur

Members

- Dr. Roshan Srivastav, Associate Professor, IIT – Tirupati
- Dr. Shamita Kumar, Principal, BVIEER, Pune, Maharashtra
- Alok Bhardwaj, Assistant Professor, IIT – Roorkee
- Dr. Seema Joshi, Vice President – Academia and Strategic Initiatives, ESRI India

Introduction

Geographic Information Systems (GIS) and Remote Sensing (RS) have become essential tools for planning, decision-making, and management across various sectors. According to IDC, the global GIS market is projected to reach $25 billion by 2030, growing at a CAGR of around 12%, reflecting its increasing significance. Governments worldwide, including India, have recognized GIS as a critical technology for informed decision-making, leading to substantial investments in geospatial technologies. Industries such as agriculture, logistics, real estate, smart cities, and climate science are increasingly integrating GIS into their operations, creating a strong demand for a well-trained workforce equipped with geospatial expertise.

The rapid advancements in GIS technology and its expanding applications across industries highlight the need for GIS academicians to stay updated with the latest tools, trends, and methodologies. Recognizing this need, institutions such as Harvard University's Center for Geographic Analysis and the University of California have successfully trained professionals in the latest trends in geospatial technology, fostering a cycle of knowledge transfer that ensures future generations are well-prepared to meet evolving industry demands.

Training trainers in advanced GIS technologies is vital to ensure the effective dissemination of knowledge and skills across industries. By equipping trainers with in-depth expertise in the latest GIS tools and methodologies, we can ensure they are well-prepared to teach others, fostering a skilled workforce capable of using GIS for informed decision-making and problem-solving. As GIS technologies continue to evolve, trained trainers are essential for staying abreast of new developments, ensuring the continued relevance and effectiveness of training programs. Moreover, well-prepared instructors play a critical role in shaping the next generation of GIS professionals, maintaining high standards in the application of GIS technologies across various sectors. Hence, to strengthen capacity building of trainers in these fields, a structured training program is crucial.

This report outlines a comprehensive roadmap for implementing a **"Train the Trainers"** program in GIS and Remote Sensing, aiming to provide widespread access to advanced geospatial education nationwide. The report further presents guidelines for developing a national training program for trainers, design training module, trainer development strategies with self-sustainable model, certification & accreditation mechanisms, and stakeholder responsibilities.

Objective of the "Train the Trainers" Program

The Train-the-Trainer Program aims to develop a robust network of GIS educators who can effectively train professionals, ensuring industry readiness with the latest geospatial skills. This structured initiative will focus on capacity building, institutional partnerships, and sustainable knowledge dissemination to create a far-reaching impact in the GIS ecosystem.

The objective is to:

- Train 100 trainers within 3 years, equipping them with advanced GIS knowledge and teaching methodologies ensuring the trained professionals collectively impart knowledge to at least 100,000 learners, preparing them for industry roles.

- Establish 10+ strategic partnerships with institutions, training organizations, and industry bodies for program delivery.

- Transitioning to a Hybrid Training Model in a span of 3-5 years. Have mix of offline to hybrid mode, balancing online theoretical learning with a one-week offline hands-on session to ensure practical application without disrupting professionals' work commitments.

- Create a Trainer Alumni Network for knowledge exchange, mentorship, and continuous learning.

Guidelines for Developing “Train the Trainers” Program

This program aims to enhance the skills and awareness of existing GIS academicians regarding the latest developments in geospatial technology. By equipping educators with up-to-date knowledge and expertise, the program needs to ensure that they are well-prepared to integrate cutting-edge advancements in Geospatial technologies into their teaching, fostering a more informed and capable generation of GIS professionals. Considering above, this **Train the Trainer** program needs to be designed considering following aspects:

- Needs to be short duration, typically **one week (5 days) module**, covering latest developments in Geospatial, Remote Sensing and related technologies

- Provide exposure to live **Case Studies & insights** how to leverage latest technology development in diverse sectors such as urban planning, rural development, disaster management, agriculture, forestry, coastal, water resources, transportation, utilities and governance etc.

- Provide insights about **key considerations, challenges experienced and Global best practices** in using different technologies

- Should include a mix of theoretical knowledge, **hands-on training**, case studies, experts’ interaction and project work. Industry participation should be encouraged for real-world exposure and latest case studies.

- A **blended learning approach** may be required – **instructor led offline mode with hands-on experience**, substantiated with online and hybrid modules, MOOCs and regular Webinars for extended learning with continuous updates.

- This pool of Trainers can then extend their learning in their respective institutions for educating students, executing research projects, organizing additional domain specific certificate programs for government organizations and delivering specialised sessions as visiting faculty to Premier Institutions.

Training for Trainers – High level Contents & Methodology

It is proposed to organize a **one-week (5 days), short-duration "Training of Trainers" (ToT) program designed to provide an intensive, advanced-level exposure to academicians and professionals who already possess a foundational understanding of geospatial concepts and tools.** The program will focus on the latest advancements in geospatial technologies, aiming to deepen participants' expertise in cutting-edge techniques and serve to upskill current educators and professionals, keeping them abreast of the latest developments. It will offer hands-on experience with advanced tools and methodologies while simultaneously equipping participants with the pedagogical skills necessary to effectively teach others. This program ensures that attendees are not only proficient in advanced geospatial technologies but also well-prepared to transfer this knowledge within their academic or professional environments.

Proposed Contents

The list of topics currently outlined is provisional and indicative, not exhaustive.

Latest Geospatial Technology Trends & Case Studies

- Latest developments in Geospatial Technologies
- Advanced Spatial Modelling, AI / ML / DL in GIS
- Case Studies primarily around current priority domains like urban & rural development, infrastructure, land records, natural resources, coastal zones, disaster management, climate change, Sustainable development, SDGs, Spatial Data Registry, business applications et all.

Data & Standardization

- Data Standardization, Modelling & Data Security
- Managing Enterprise Geodatabases
- Accessing Open Data & APIs

Solution Architectures & Deployment Strategy

- Essentials of Internet and Web Technologies
- Standalone, Web, Mobile & Cloud GIS Technologies
- Geospatial Technology Solutions – Architecture, Design & Deployment Patterns

Advance Application Development

- Advance Python Programming for Spatial Analytics
- Using GeoAI (AI, Machine Learning & Deep Learning) for Analytics

Other Related Technologies

- Advance Spatial Data Sciences & Big Data Analytics
- Video Analytics & Real-time GIS
- Digital Twins & 3D GIS Modelling
- UAVs, Drones, Augmented Reality (AR) & Virtual Reality (VR)
- Geospatial Data integration with IoT & Blockchain

Best Practices

- GIS Project Lifecycle & Best Practices
- Key Challenges, Policy and Legal Aspects of GIS and Remote Sensing
- Research Project Formulation
- Communication skills, Presentation skills and effective pedagogy

Additional Specialized short duration (3-5 days) Training Modules on focussed domains and advance Geospatial technologies like Geo AI/ML/DL, AR/VR, IoT, Video Analytics, Blockchain, Sensors, Drones etc. can be planned based on participant's feedback.

Training Methodology

- Presentations, Videos, Live Demos, Hand-on Exercises (interactive elements such as simulations, problem-solving exercises, and role-play scenarios), Expert Interaction, Field Visits with assessment to ensure knowledge upgrade.

- **Certification as Master Trainers** based on Assessment & Evaluation during Program. The participants will be assessed through:
    - Practical assignments and hands-on exercises
    - Written tests and presentations
    - Peer evaluation and feedback

- **Training Materials** – Presentations, Online Tutorials, White Papers, Case Studies, Research Papers & Publications

- Guest lectures and expert interactions with leading industry professionals on real-world case studies.

Who can attend

Working academicians and professionals with teaching experience, who already possess a foundational understanding of geospatial technology with hands-on skills in using GIS Software & tools and who are engaged with Education and Training activities in Geospatial domain.

Developing a Pool of Trainers across the Country

- Identification of GIS and RS Professionals from academic institutions, industry, and government agencies.

- Establishment of Trainer Certification to standardize teaching methodologies.

- Regional distribution of trainers to ensure accessibility across North, South, East, and West zones.

- Creation of a National GIS and RS Trainers Network (NGRTN) for continuous skill enhancement and sharing of best practices.

- Regular **Training of Trainers** programs conducted by national and international experts.

- Policy Mandate (at UGC/DST level) – **At least one Master Trainer** in each institution imparting M.Tech Program in Geo-informatics to mentor junior trainers, improving scalability.

- **Incentives / Awards for becoming Master Trainer** in Geo-informatics. Regular assessments, periodic skill audits, and refresher training to ensure trainers maintain updated knowledge.

Opportunities for Master Trainers after attending "Training for Trainers"

- **Industry-Endorsed Trainer Certification:** Co-branded certificates with industry partners

- **Accreditation by Government and Academic Bodies:**
  - National GIS and Remote Sensing Accreditation Board (to be formed)
  - Recognized by **AICTE, UGC, Ministry of Science & Technology**
  - International accreditation from **GSDI, ISO, and ICA.**

- **DST to Prioritize Master Trainers** for **DST Projects**

- **Generate Revenue for Institutions** by organizing short-term, diploma, and advanced programs.

- **Government and Industry Sponsorships:** Collaboration with ministries, public sector organizations, and private companies as **Academic Experts for evaluating Bids & Tenders.**

- **Consultancy Services:** Offering GIS-based project services to organizations.

- **Software Licensing:** Special software licenses and subscriptions.

- **Grants and Research Funding:** Seeking funds from research councils and international donors.

- **Corporate Training Programs:** Customized GIS training for industries and government departments.

- Play a key role in developing **GIS Professionals with Employment Opportunities for their Students**

- Awards, certificates of excellence, and performance-based incentives for top-performing trainers.

- Encourage Master Trainers to join global GIS networks to exchange best practices and innovations.

Roles and Responsibilities

Role of ESRI India

- Providing software support and academic licensing to institutions collaborating for ToT Programs.
- Support in developing specialized course modules and industry-relevant trainings.
- Providing experienced Training Faculty for specific sessions & modules for this ToT program.

Role of Host Institutions collaborating to organize "Training for Trainers" Program

- Serving as training centres with necessary infrastructure (labs, software, internet).
- Promoting GIS education and skill development in their respective regions.
- Hosting guest lectures, workshops, and research collaborations.
- Managing administrative functions such as student registration, certification, and assessments.
- Establish labs with necessary infrastructure, hardware and software as per configuration requirements along with good internet connectivity and projection system etc.

Expectations from Master Trainers

- **Become Program Coordinators:** Managing course design, trainer selection, and scheduling trainings in their region.
- **Senior Trainers:** Delivering high-level modules and mentoring junior trainers.
- **Industry Experts:** Bringing practical insights and case studies in collaboration with Industry Experts.
- **GIS and Remote Sensing Researchers:** Ensuring the latest advancements are incorporated into training modules & Research Projects.
- **Encourage Participation in Policy Development:** Master Trainers to actively contribute to shaping GIS education policies and curriculum frameworks, ensuring alignment with industry and academic needs.
- **Facilitate Research Collaborations:** Establish links between Master Trainers and research organizations to drive innovation, interdisciplinary studies, and real-world applications of GIS.
- **Promote Mentorship and Capacity Building:** Enable Master Trainers to mentor educators and students, fostering a strong knowledge-sharing ecosystem.

Significance of the initiative

The establishment of a structured **"Train the Trainers"** program for Academicians in Advance Geospatial Technologies will enhance national capacity, foster innovation, and drive economic development. By leveraging industry partnerships, academic institutions, and government support, this initiative will create a sustainable ecosystem for enhancement of skills in geospatial education and application.

The idea of establishing a structured "Train the Trainers" program for academicians in advanced Geospatial technologies is a visionary and impactful approach. By equipping educators with cutting-edge skills and knowledge, the program can create a multiplier effect, ensuring that knowledge and expertise are passed on to future generations of students and professionals. This, in turn, can drive national capacity building, innovation, and economic growth in the field of geospatial technologies.

Here's why such an initiative is significant:

Enhanced National Capacity

- **Developing a Skilled Workforce:** A well-trained pool of educators will ultimately produce a skilled workforce that can handle complex geospatial problems, benefiting industries like urban planning, agriculture, environmental monitoring, and disaster management.

- **Building Local Expertise:** By empowering local academicians, the program encourages homegrown expertise in the field, reducing dependence on foreign specialists and creating a self-sustaining knowledge ecosystem.

Fostering Innovation

- **Academic-Industry Collaboration:** Collaborating with industries can facilitate the transfer of real-world challenges and innovations to the academic environment, encouraging research and development in geospatial technologies. This can result in the creation of new products, solutions, and startups.

- **Incorporating Emerging Trends:** As geospatial technologies rapidly evolve (e.g., the rise of AI, machine learning, drones, and satellite-based systems), the program ensures that academic professionals are kept up to date and can drive new, innovative applications in both research and practice.

Driving Economic Development

- Increasing Market Competitiveness: With a workforce skilled in advanced Geospatial technologies, countries can position themselves as leaders in this growing field. This can attract investment, create high-tech jobs, and fuel the development of geospatial businesses.

- Optimizing Resource Management: Advanced geospatial technologies can help with efficient land use, sustainable development, and environmental conservation, all of which contribute to long-term economic benefits.

Sustainable Ecosystem for Geospatial Education and Application

- **Continuous Professional Development:** This program can serve as a long-term framework for continuous professional development, ensuring that educators remain on the cutting edge of their field and are always able to teach the latest technological advancements.

- **Government and Industry Support:** By involving key stakeholders such as government agencies and industry leaders, the program can be appropriately funded, aligned with national goals, and tailored to the needs of the marketplace.

Ultimately, such a "Train the Trainers" program creates a cycle of knowledge and skill-building that directly contributes to the growth of the geospatial technology sector and its application across various industries, benefiting the economy and society.

Recommendations

- For better adaptability, it is recommended to have the program rotationally hosted by institutions that demonstrate commitment and readiness to support such training. This decentralized model will:
    - Ensure greater participation from diverse regions and institutions.
    - Encourage institutional ownership and leadership in GIS training.
    - Allow for flexible integration of specific training needs.

- Get affiliation & sponsorship from DST / AICTE etc. to organize Training for Trainers on regular basis, as per their Faculty Development Program.

- Establish a National GIS & RS Training Committee under National Geospatial Mission.

- Launch pilot programs in select institutions.

REPORT

TASK FORCE ON INTERDISCIPLINARY COLLABORATION

03 Interdisciplinary Collaboration

Background

The term **interdisciplinary collaboration** in a broad sense "*... brings together people from two or more disciplines to work in such a collaborative fashion across disciplinary boundaries; this approach facilitates the combination of different methodologies from the disciplines in order to try to answer multifaceted, real-world problems (Aboelela et al. 2007).*

The collaboration is "... inspired by the drive to solve complex questions and problems, whether generated by scientific curiosity or by society ... " and has led " ... researchers in different disciplines to meet at the interfaces and frontiers of those disciplines and even ... form new disciplines." (National Academy of Sciences, National Academy of Engineering and Institute of Medicine, 2004).

It is realized that Geospatial Technology/Science (GITech/GIScience) is essentially a multidisciplinary subject. Almost every subject/domain uses a part of GITech/GIScience be it Remote Sensing, GIS or GNSS etc. Since their requirements are met with a part of it, most domains treat this subject as a tool rather than a complete science or technology and are usually interested in acquiring only certain limited skill sets as is required. This has prevented this subject (GITech/GIScience) getting recognized as an independent discipline. Integrating Geospatial technologies into interdisciplinary courses is a powerful way to enhance students' understanding of how geographic data and tools can be used in solving complex problems. Geospatial technologies, including Geographic Information Systems (GIS), Remote Sensing (RS), Global Positioning Systems (GPS), and spatial analysis tools, have wide applications across various. Following is detailed overview where Geospatial technologies can be leveraged effectively by different disciplines:

- **Environmental Science & Ecology:** Land Use/Land Cover (LULC) Monitoring, Deforestation & Habitat Loss, Climate Change Studies.
- **Urban & Regional Planning:** Smart Cities, Disaster Risk Reduction
- **Agriculture & Precision Farming:** Crop Health Monitoring, Soil Moisture & Irrigation
- **Mining, Resource Management, Geology & Hydrology**: Mineral Exploration, Watershed Management, Disaster Management, Earthquake & Landslide Mapping, Wildfire Tracking, Open-Pit Mine Monitoring, Resource Exploration
- **Public Health & Epidemiology**: Disease Mapping, Air Pollution Analysis
- **Transportation, Infrastructure & Logistics**: Route Optimization, Autonomous Vehicles, Railway & Highway Maintenance, Airport Noise Mapping.
- **Oceanography & Marine Sciences**: Coral Reef Monitoring, Oil Spill Detection, Coastal Erosion
- **Forestry & Wildlife Conservation**: Illegal Logging Detection, Wildlife Corridor Planning
- **Energy & Renewable Resources**: Solar/Wind Farm Siting, Pipeline Monitoring
- **Defense & Security**: Border Surveillance, Military Terrain Analysis

- **Public Safety & Law Enforcement**: Crime Hotspot Analysis, Search & Rescue
- **Archaeology, Cultural Heritage & Tourism**: Site Discovery, UNESCO Site Preservation, Tourism Route Planning
- **Insurance & Risk Assessment**: Flood Insurance Modelling, Crop Insurance
- **Climate Adaptation & Resilience**: Urban Heat Island Effect, Sea-Level Rise Modelling
- **Humanitarian Aid & Refugee Management**: Displaced Population Mapping, Conflict Damage Assessment
- **Retail & Market Analysis**: Site Selection for Businesses, Supply Chain Logistics
- **Engineering**: Computer Science, Civil, Environmental, Mechanical, Electrical, Geotechnical Engineering

Fig.1. GIS applications across disciplines

To address this need, the Task Force on **"Interdisciplinary Collaboration"** under the aegis of the GIS Academia Council of India (GACI), has been established with the primary objective of developing a comprehensive guideline. This guideline will serve as a framework to facilitate interdisciplinary collaboration across various applied disciplines. The task force also seeks to explore strategies for enhancing the adoption of Geographic Information Systems (GIS) in interdisciplinary contexts. In its efforts, the task force aims to offer a holistic approach that encompasses subject matter content, technological advancements, pedagogical strategies, and future developments.

Objective of Task Force

The main objective of the task force is to promote the adoption and application of GIS in cross-cutting disciplines, encouraging innovation, research, and practical skill-building for students, faculty and mid-level professionals. The task force aims to:

- Foster collaboration between different academic disciplines (e.g., engineering, environmental sciences, urban planning, social sciences, etc.) to integrate GIS into their curriculum.

- Develop common curriculum framework for all to appreciate GIS in cross-sectoral applications

- Develop strategies for interdisciplinary research using GIS tools and methodologies.

- Enhance awareness and understanding of GIS applications across diverse fields and the futuristic development in the domain of GIS.

- Innovation in pedagogy is required so that the content can be reached by anyone who is interested in the GIS domain by promoting free online tutorials, course content and datasets to work with.

- Encourage knowledge sharing and capacity building for faculty and students in interdisciplinary spatial studies.

- Provide a framework for integrating GIS tools and techniques into existing educational programs without imposing mandatory guidelines.

Scope of the Task Force

The task force is expected to focus on the following key activities:

- Promote interdisciplinary research projects that utilize GIS data and methodologies.
- Capacity building workshops and basic and uniform curriculum for faculty development programs.
- Innovate pedagogical and promote open-source learning
- Promote awareness and visibility of GIS applications and its future development across academia, industry and non-governmental/governmental organizations.

Task Force Members

Chair: Prof. Chander Kumar Singh, TERI School of Advanced Studies

Members

- Prof. Seema Jalan, Mohan Lal Sukhadia University
- Prof. Dheeraj Kumar, Indian Institute of Technology (Indian School of Mines)
- Dr. Vijaya Lakshmi Thatiparthi, Jawaharlal Nehru Technological University
- Dr. Seema Joshi, Vice President – Academia and Strategic Initiatives, Esri India

Discussion Points

To bring in interdisciplinarity Task Force members felt that it can be built on the four pillars:

Content Knowledge: The content should be created maintaining the interdisciplinary character of discipline. This would enable people from diverse discipline to realize the potential of GITech/GIScience and its applicability in realizing/understanding the spatial problem and further in providing the solution.

Pedagogical Knowledge: Innovation is required in the pedagogy to make it simple and

Technological Knowledge: Those inclined towards technicalend should understand the spatial approach towards finding the solution to the problem

Future Development in GItech/GIScience and employability in different sectors/discipline. The futuristic unfolding of the discipline and thus the employability issues should be addressed.

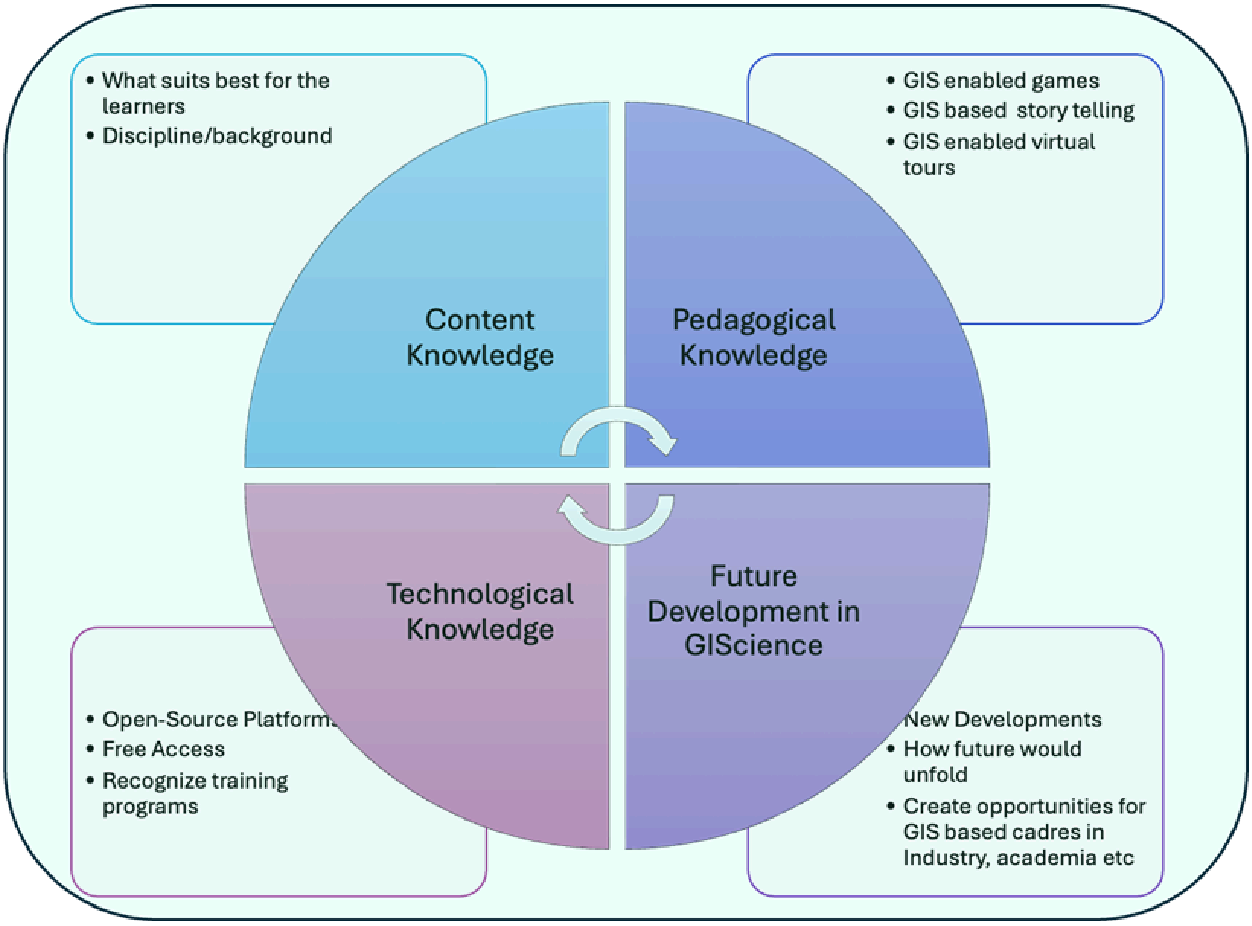


Fig.2. Interdisciplinary Collaboration to diversify the discipline

The interventions were proposed for different categories of stakeholders. As per the objectives of the task force, the stakeholders may be broadly categorized as

- Students,
- Faculty / academia (primarily engaged in teaching and research), and
- Research community (scientists, doctoral and post-doctoral researchers).

The first two communities listed above comprise of the students and faculty, at all three progressive levels of specialisation – schools, higher education, and technical education, whereas the third category of research community comprises the researchers at the two higher levels. 'Multi-faculty higher education' indicates all disciplines other than the STEM viz. humanities, social sciences, education, law, archaeology etc.

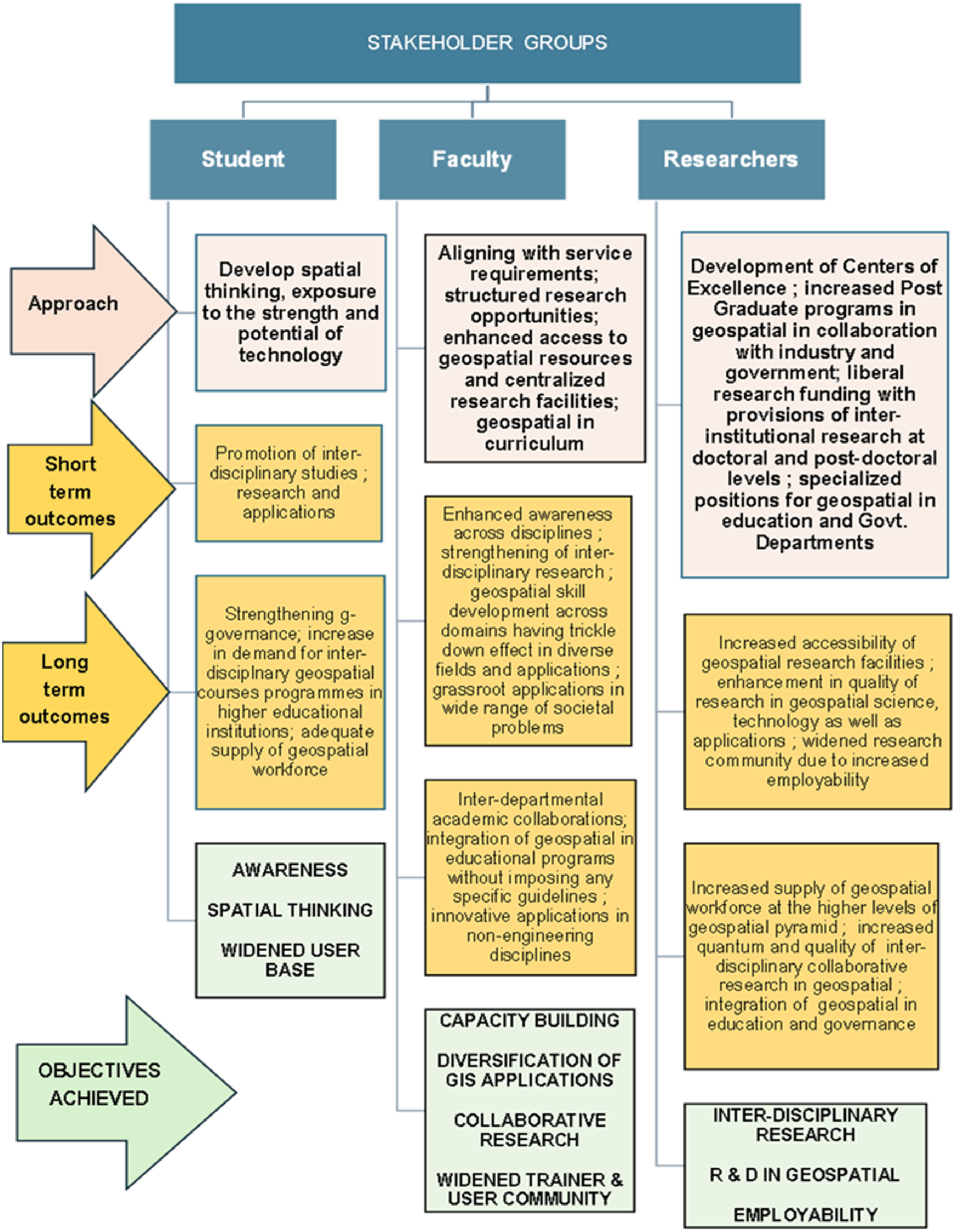


Fig.3. Strategy for promoting inter-disciplinarity in GITech/ GIScience for different stakeholders

The discussion of the Task Force on "Interdisciplinary Collaboration" centred around certain generic observations as below:

- Due to lack of a standard unified Geospatial academic and employment policy, there are many nomenclatures with varying definitions. As a result, the Govt, the Academia and the Industry often have divergent perceptions with respect to the various nomenclatures in use. It is therefore pertinent to that guideline be issued for standardization of various nomenclatures being used in reference to geospatial technology domain.
- It is observed by all that though this subject (Geospatial Technology) merely exists at school level as an optional but is also opted by only a few students because they don't see a career in it. The lack of Geospatial Science or Geospatial Technology Courses at UG level is a concern and can be introduced as compulsory course.
- Need for National Level unified training programs/recognize the program through regulatory bodies (AICTE/UGC/NCERT/SCERTs)
- Availability of Free online portal, educational resources for schools and basic training material for beginners
- Organize National Level Workshops to bring diverse discipline stakeholders from academia, application-oriented industry futuristic evolvement.

Recommendations

The members raised several issues to promote the interdisciplinarity wherein it was felt that the approach to promote GItech/GIScience should involve short- and long- term objectives. Integrating Geospatial technologies into curriculum of applied disciplines can create more robust and practical learning experiences. By integrating GIS, remote sensing and GPS principles and applications students will be better equipped to approach complex problems that span multiple disciplines, ultimately enhancing their understanding of how to design, optimize, and manage systems in the real world by leveraging on Geospatial & related technologies.

Considering above requirements, with limited scope and stringent timelines, following aspects can be considered as Short-term initiatives:

Enhancements in Course Structure

- Develop model Course Module (typically 2-3 Credits), which can be opted by students of different engineering, geography and environment related streams which can in long term be expanded to other disciplines too.
- This course can be designed in such a way to provide foundational knowledge along with domain specific applications on the Geospatial & related technologies for different streams.
- In addition, provision to be explored for integrating/embedding Geospatial/locational intelligence aspects in existing course modules.

Offerings & Roll Out

Till the time, this course gets established as a separate stream, this foundational course on

Geospatial technologies can be made mandatory for selected streams like Computer Science, Civil Engineering, Urban Planning, Architecture, Environment, Geography etc. and can be offered as an elective by students of other streams.

- Universities / Institutions who are already teaching Engineering / Environmental Sciences etc. should be prioritized for Pilot roll-out plan as the resources / infrastructure / procedures/ approvals will be quick and can be implemented immediately.
- The institutions which offer engineering / degree courses in RS-GIS can float elective courses emphasizing the role of geospatial applications in different domains like forestry/ water/ climate/ meteorology/ transport/ urban/ natural resources/ archaeology/ social sciences/ economics etc
- GACI Member Institutions to become the Role Model and launch these initiatives

Additional options

- Harnessing the National Education Policy which mandates all the PG / UG students to undertake a Value-Added Course/Skill Enhancement Course.
- The basic course in GIS can be introduced as a Skil Enhancement Course (SEC)
- FDP's/Refresher courses can be designed on disseminating the interdisciplinarity of GItech/GIScience in respective institutions in coordination with DST, AICTE etc
- It was suggested by members that a course mostly on interdisciplinary applications of RS-GIS can be floated on SWAYAM/NPTEL/MOOC etc platforms with Open access, in collaboration with Industry.
- Plan Workshops / webinar series for all the basic sciences discipline, where the work/case studies involving interdisciplinarity should be disseminated in most simplistic language. to disseminate the idea of spatial thinking.
- Encourage interdisciplinary geospatial research through funding and travel grants.
- Start organizing GIS/Remote Sensing Days in schools and colleges and universities and encourage participation by bringing up posters by students on various thematics of GIS
- Organize Hackathons / Ideations based on Interdisciplinary Challenges
- Develop online resource repositories of Geospatial knowledge
- Foster industry-academia collaboration for virtual labs and Centres of Excellence (CoE's).

Long term considerations

School education is the root of the education, industry, governance and research infrastructure of a country. The knowledge, vision and perspective developed at school level flows in all the fields which the younger generation joins as student/ researcher at higher educational levels, and eventually as workforce in due course of time. Therefore, exposure to the geospatial technology at school level shall have ramified effects in strengthening the geospatial ecosystem of the country in the long run.

The following interventions are suggested at school level:

- Awareness workshops for students and faculty.

- Dedicated summer camps / institutional visits supported by ISRO / DST/ Industry.
- Special sessions for students in ISRS/ ISG/ NRSC/ ESRI User Meet/ Conferences.
- Technothons / competitions / essay competitions/ debates / Story Maps on special days like GIS Day, National Science Day etc.
- Introducing chapters/ courses in the curriculum at primary and secondary levels with progressive levels of complexity. Elective subject at senior secondary level.
- Popularization of geoportals/ apps like School Bhuwan, ArcGIS Living Atlas etc. Geotagged data collection may be integrated through project works. Special workshops/ webinars may be held in online/ offline mode especially designed for school children.
- ESRI's school outreach program can be initiated through the GACI member institutions and internship to selected students can be offered at nearest ESRI's centre locally or centrally at any location
- Mandate UGC/NCERT/SCERT's to implement courses of interdisciplinary nature of GIS which would be designed as highlighted in the actionable points mentioned above.
- A group of geospatial experts can be formed with sectorial expertise which can visit institutions around the country to popularize the GItech/GIScience and its interdisciplinary nature
- Several of the institutions can be identified as GItech/GIScience expert institutions which can offer and initiate dialogues with institutions willing to launch programs related to GItech/GIScience. They can act as mentor to willing institutions.
- The application specific courses/specialization modules can be developed and launched for students from diverse disciplines
- Develop short-term training modules for faculty: Need for faculty training and recommended aligning efforts with existing working groups for short-term training program.
- Introduce GIS terms into school curricula in coordination with existing content: At the school level, integration of GIS concepts into existing geography curricula like introducing terms such as remote sensing, satellite imagery, and Bhuvan in a simplified format. Use of relatable examples (e.g., Google Maps) to make concepts intuitive.
- Compile and format India-specific case studies and publish institutional experiences and user-based studies.

Key Considerations for Foundational Interdisciplinary Course Design

1. **Define the Learning Outcomes and Objectives**
   To ensure that students grasp the interdisciplinary nature of Geospatial technologies, outline specific learning outcomes for each module:
      - Understanding basic concepts of Geospatial technologies.
      - Applying GIS and remote sensing tools to solve problems.

- Integrating Geospatial data in diverse disciplines.
- Analysing Geospatial data for decision-making in real-world projects.
- Developing hands-on skills in the use of Geospatial software tools and platforms.

2. Develop Interdisciplinary Projects

Focus on practical, hands-on projects that require students to use Geospatial data in conjunction with other applied disciplines. These projects can bridge multiple fields, fostering collaboration among different disciplines like:

- **Smart City Design**: Combine urban engineering, electrical engineering, and GIS to design an efficient, sustainable city, incorporating transportation, energy, waste management, and emergency response systems.
- **Supply Chain and Logistics Optimization**: Integrate GPS data, GIS, and mechanical engineering to optimize the transportation and distribution of goods.
- **Environmental Impact Assessment**: Use GIS and remote sensing to evaluate the potential environmental impact (e.g., dam, road, industrial plant).
- **Renewable Energy Projects**: Apply geospatial analysis to identify optimal locations for renewable energy infrastructure like wind farms or solar panels.

3. Incorporate Geospatial Technologies into Existing Curriculum of applied disciplines

- **Foundational Courses:** Start by introducing the basic concepts of Geospatial technologies in foundational courses, such as Introduction to Engineering, or even specific courses like Surveying, Geographic Information Systems (GIS), GIS applications in interdisciplinary subjects, Environmental applications or Remote Sensing. Use software like ArcGIS, QGIS, or Google Earth Engine.
- **Engineering Design Courses**: Integrate Geospatial data as part of engineering design courses, where students need to use GIS for site selection, design validation, and optimization.
- **Project-Based Courses:** In advanced, project-based courses, students can use Geospatial technologies to work on real-world challenges. This will provide exposure to how Geospatial data intersects with cross-sectoral disciplines.

4. Incorporate Software and Tools

- **GIS Software:** Teach students how to use GIS software to create maps, analyze spatial data, and perform spatial analysis.
- **Remote Sensing Software:** Introduce software tools on Image processing.
- **GPS Technology**: Demonstrate how to use GPS systems for fieldwork, data collection, and navigation purposes.
- **Geospatial Modelling and Analysis Tools**: Introduce tools for modelling and complex spatial analysis.

5. **Collaborate with Industry and Research Initiatives**

Encourage collaboration with industry partners, local governments, or research institutions that specialize in Geospatial technologies. Industry experts can provide guest lectures, real-world case studies, or project opportunities. Research initiatives involving Geospatial data (e.g., climate modelling, disaster preparedness) can provide valuable insight into practical applications.

6.Promote Cross-Disciplinary Learning

Encourage interdisciplinary collaboration by creating opportunities for students from different applied disciplines to work together:

- **Workshops & Hackathons:** Organize workshops or hackathons on Geospatial technology applications, where students from various disciplines can tackle real-world problems using these technologies.
- **Group Projects:** Assign group projects where students from different engineering fields work together to solve a problem that requires expertise in Geospatial technologies, such as designing a sustainable energy grid or urban transportation system.

6.Provide Training and Certification

Many students may not be familiar with Geospatial technologies or may have limited exposure. Offering additional training or certification in tools like GIS, Remote Sensing, or GPS can add significant value:

- Partner with institutions like Esri or other organizations that offer GIS training and certification.
- Provide access to online courses or tutorials on platforms like Coursera, Udemy, or LinkedIn Learning.

7.Assessment and Evaluation

In interdisciplinary courses, assess students through:

- Project-based assessments: Evaluate students based on their ability to apply Geospatial technologies to engineering problems.
- Practical exams: Assess technical skills in using GIS, remote sensing tools, and GPS systems.
- Collaborative evaluations: Assess group projects that require students to work across engineering disciplines.
- Research papers and case studies: Ask students to write papers or reports based on case studies or their projects using Geospatial technologies.

8.Encourage Real-World Problem-Solving

Geospatial technologies should be seen not just as theoretical tools but as practical solutions to real-world problems. Foster an environment where students can use these technologies to address engineering challenges like:

- Environmental monitoring and restoration.
- Infrastructure planning and urbanization.
- Disaster management and resilience planning.
- Transportation and mobility optimization.

By integrating Geospatial technologies into interdisciplinary courses, students gain valuable skills that are applicable across various industries and engineering fields. They learn to leverage data for better decision-making, enhancing both their technical knowledge and problem-solving capabilities. This also prepares them for the increasingly data-driven, interconnected world they will encounter in their careers.

Benefits for Students:

- Enhanced Problem-Solving: Students can tackle complex engineering problems by incorporating spatial data and analysis.
- Interdisciplinary Learning: Geospatial technologies naturally encourage collaboration between different engineering disciplines.
- Industry-Relevant Skills: Many industries—urban planning, environmental science, energy, agriculture, and infrastructure—are increasingly relying on Geospatial tools. Students will develop skills that are highly valued in the workforce.

Course Structure across Disciplines

Finalize differentiated course structure across disciplines: Emphasis on tailoring course content based on academic disciplines as the differential approach will help better align the course with the baseline understanding of each student cohort:

- Humanities & Social Sciences: Should emphasize conceptual outcomes and applications with minimal mathematical intensity.
- Engineering & Science: Can incorporate more technical depth and analytical components.

Model Curriculum

A model curriculum is proposed with a three-tier structure:

1. **Basic Level:** Introductory course for undergraduate students.
2. **Advanced Level:** For students with a stronger interest or background.
3. **Research Level:** For postgraduates and Ph.D. students with potential integration into dissertation work. Ph.D. students be offered GIS and Remote Sensing as either a mandatory or elective course.

Geospatial Sciences for Students of All Disciplines (3-credit course)

This model curriculum is designed to introduce geospatial sciences to studentsacross disciplines, ensuring a foundational understanding while allowing flexibility for interdisciplinary applications. It is structured into core modules (mandatory for all) and elective modules (tailored to specific disciplines). The differential course structure across disciplines should emphasize on tailoring project/course content based on academic disciplines which will help better align the course with the baseline understanding of each student cohort:

Core Module(Foundation Level) – 34 Hours

(Mandatory for selective streams and elective for other streams)

Module 1: Introduction to Geospatial Sciences(6 hours lecture + 2 hrs tutorial)

- Overview of geospatial sciences: GIS, remote sensing,GPS, and spatial analysis.
- Applications of geospatial technologies in variousfields (e.g., environment, health, urban planning, infrastructure, utilities, agriculture).
- Basic concepts: spatial data, coordinate systems, and map projections.
- Types of geospatial data: vector, raster, and tabular.
- Spatial Data Sources: Toposheets, GPS, satellite imagery, drones, and surveys.

Module 2: Geospatial Tools, Analysis and Visualization (6 hrs lecture+ 2 hrs tutorial)
- Introduction to geospatial software
- Basic spatial analysis techniques: overlay, buffering, and interpolation.
- Data visualization: creating maps, charts, and 3D models.
- Interpretation of spatial patterns and trends.

Module 3: Geospatial Technologies – Implementation Patterns, Ethics & Policies (6 hrs lecture + 2 hrs tutorial)
- GIS implementation Patterns – Standalone, Web, Mobile & Cloud GIS
- Geospatial databases - Standardization, Modelling & Management
- Ethical considerations in data collection, usage, privacy, security & sharing
- National and international geospatial policies (e.g., OGC, National Geospatial Policy, INSPIRE Directive).

Module 4: Geospatial Technology Trends (6 hrs lecture+ 4 hrs tutorial)
- Geo AI – AI/ML/DL & Predictive Modelling, Locational Intelligence
- IoT, Sensors & Drones
- Digital Twins
- Big Data Analytics
- AR/VR & Video Analytics

Module 5: Project (Discipline-Specific Applications & Case Studies)
Students will undertake Project based on theirfield of study. Project will be of 22 hrs duration which will be detailed as follows:
- Practical and Skill Development Components (22 hrs)
- Hands-on Training
    - Lab sessions using geospatial software
    - GPS data collection, and ground truthing.
    - Case studies and real-world problem-solving exercises.

The students depending upon their interest and skill enhancement may opt for projects which would include basic, advanced level of applications of GIS. The institutions may also opt for specific applications depending upon the orientation of institution into the domain of humanities and social sciences/science and engineering.

Project
- Interdisciplinary group projects applying geospatial tools to solve real-world problems.
- Collaboration with industry, government, or NGOs for practical exposure.

Industry and Research Exposure
- Guest lectures by geospatial experts from industry and academia.
- Internships with geospatial companies or research organizations.
- Participation in geospatial hackathons and conferences.

Assessment and Certification
- Continuous Evaluation: Quizzes, assignments, and lab exercises.
- Project-Based Assessment: Capstone project presentation and report.

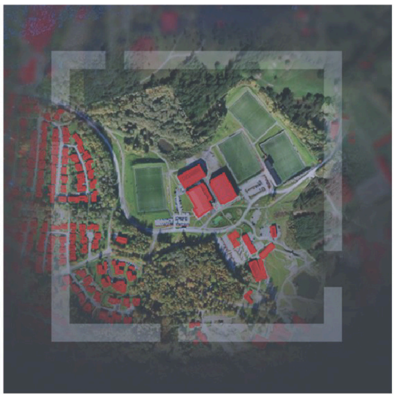
- Certification: Students receive a certificate upon completion, with credits transferable under the National Education Policy (NEP).

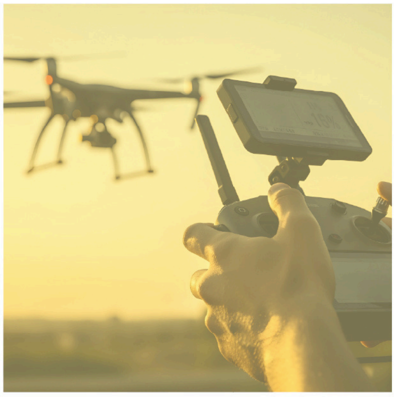
Resources and Support

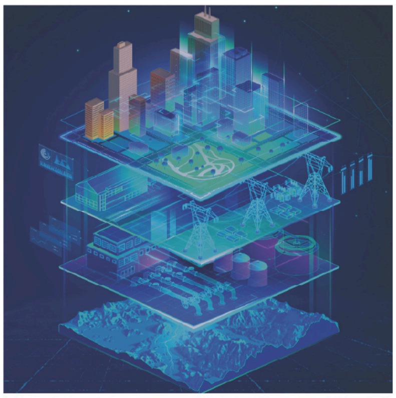
- Online Learning Platforms: MOOCs, e-books, and tutorials.
- Virtual Labs: Access to proprietary geospatial software and datasets.
- Mentorship: Guidance from faculty and industry professionals.

Outcome of Course Module

This curriculum equips students from all disciplines with foundational geospatial skills, enabling them to apply geospatial tools and techniques in their respective fields. It fosters interdisciplinary collaboration and prepares students for careers in academia, industry, and government.





GIS Academia Council of India

gaci@esri.in go.esri.in/gaci +91 120 4694900