Mafatlal Gagalbhai Science Institute (Autonomous) (M. G. Science Institute), Ahmedabad Accredited "A" level by NAAC (3rd Cycle)

Managed by The Ahmedabad Education Society

Affiliated to Gujarat University (Recognized by University Grants Commission)

SYLLABUS (As per the guidelines of UGC) (Outcome Based Education Pattern)

for

M. Sc. SEMESTER - I & II

Based on National Education Policy (NEP) 2020

For Post - Graduate Degree in

GEOINFORMATICS

(In force from June, 2025)

Two year – four semester studies leading to degree of Master of Science (M. Sc.)

Submitted by

Geology Department M. G. Science Institute Navrangpura Ahmedabad – 380 009.

PROGRAM SPECIFIC OUTCOMES (PSOs)

On completion of the course the learner will be able to

PSO 1: Academic Skills

- i. Understanding key concepts such as Remote Sensing, GIS, GPS, Digital Image Processing, and Spatial Modelling.
- **ii.** Applying theoretical principles from Earth sciences, cartography, geodesy, and geospatial technologies to address spatial problems.
- iii. Integrating interdisciplinary knowledge from geology, geography, physics, and computer science to interpret geospatial data and critically evaluate satellite imagery, interpretation methods, and data structures.

PSO 2: Laboratory Skills

Gain hands-on expertise in advanced geospatial tools and data management by operating software like ArcGIS, ENVI, SAGA, and ERDAS, performing image processing techniques, integrating GNSS-based data, and managing spatial databases with precision for analytical and research purposes.

PSO 3: Personal Skills

Develop independent learning, time management, and critical thinking abilities by engaging in seminars, presentations, and project work, while adapting to emerging technologies and solving complex geoinformatics problems through analytical reasoning and programming.

PSO 4: Social Skills

Collaborate within multidisciplinary teams and communicate geospatial insights effectively to support environmental management, urban planning, and disaster mitigation, while upholding ethical standards in geospatial data handling and promoting sustainable, community-oriented solutions.

PSO 5: Employment Skills

Prepare for professional roles in government, private, and research sectors by designing geospatial applications using programming languages such as Java and PHP, mastering web GIS and remote sensing tools, and demonstrating job-readiness through practical training, viva, and project-based assessments.

M. G. Science Institute (Autonomous)

Design and structure of Geoinformatics for PG Courses

Depart ment	Seme ster	Course			No. of Hours per week			
		No.	Name	Lect ures	Pract icals	Total		
Geology	Ι	GINF 401	Introduction to Geoinformatics	4		4	4	
		GINF 402	Principles of Remote Sensing	4		4	4	
GINF 403 Principles of Geographical Information Systems		4		4	4			
		GINF 404	Principles and Applications Of GPS	4		4	4	
GINF 405 PR Geographic Information System Lab.			8	8	4			
		GINF 406 PR	Image Processing and GNSS Lab. + Viva Voce		8	8	4	
			Total	16	16	32	24	
	Π	GINF 407	Digital Image Processing for Geoinformatics	4		4	4	
		GINF 408	Web Programming	4		4	4	
		GINF 409	JAVA Programming	4		4	4	
		GINF 410	Spatial Database and Modelling	4		4	4	
		GINF 411 PR	Remote Sensing, Digital Image Processing and Photogrammetry Lab.		8	8	4	
		GINF 412 PR	Web & JAVA Programming		8	8	4	
			Total	16	16	32	24	

COURSE OUTCOMES (COs):

On completion of the course, students will be able to

- CO 1: Gain fundamental understanding of Geoinformatics by exploring its interdisciplinary scope, Earth systems, modern surveying methods including GPS, and execute geodata visualization in 2D, 3D, and web formats.
- **CO 2:** Comprehend the physics of electromagnetic radiation, analyse spectral reflectance, evaluate sensor-platform characteristics, and apply visual interpretation techniques for thematic mapping.
- **CO 3:** Develop GIS capabilities by managing spatial data through raster and vector models, perform data input-output operations, and apply cartographic principles and projection systems for accurate map production.
- **CO 4:** Understand satellite navigation concepts including GPS and Indian systems like IRNSS and GAGAN, and execute GPS data acquisition, processing, and GIS integration.
- **CO 5:** Perform GIS operations using ArcMap and ArcCatalog, apply symbology, coordinate transformations, and execute map projection tasks for spatial data visualization and execute digital image processing using ENVI/SAGA, perform georeferencing and corrections, and conduct GNSS-based field surveys for geospatial data acquisition.
- **CO 6:** Comprehend digital image formats and enhancement techniques, perform supervised and unsupervised classification, and analyse hyperspectral data using feature extraction and dimensionality reduction methods.
- **CO** 7: Develop responsive web applications using HTML, CSS, JavaScript, and PHP, and execute backend connectivity with MySQL for dynamic content and data management.
- **CO 8:** Gain proficiency in Java programming including OOP concepts, multithreading, GUI development, and develop advanced applications using Applets, Servlets, JavaBeans, and network components.
- **CO 9**: Accomplish spatial database design using SQL, comprehend spatial data models, assess data quality and uncertainty, and perform normalization and metadata management for reliable spatial analysis.
- **CO 10:** Perform digital image enhancement, corrections, and classification, and use photogrammetric tools for accurate spatial measurements and 3D mapping. Develop interactive web and Java applications, connect them with databases, and validate functionality through project-based assessments and viva voce.

PSO-CO Mapping Table

COs ↓ / PSOs →	PSO 1 (Academic Skills)	PSO 2 (Lab Skills)	PSO 3 (Personal Skills)	PSO 4 (Social Skills)	PSO 5 (Employment Skills)
CO 1	3	-	2	2	-
CO 2	3	_	1	_	_
CO 3	3	_	2	1	1
CO 4	3	-	2	-	-
CO 5	2	3	1	-	3
CO 6	3	-	2	-	-
CO 7	2	-	2	-	3
CO 8	2	_	1	_	3
CO 9	3	_	1	_	2
CO 10	2	3	3	3	3

Attainment Level Target (0–3 scale)

- 0: Not Attained
- 1: Low Attainment
- 2: Medium Attainment
- 3: High Attainment

Semester I Geoinformatics THEORY and PRACTICALS Course-wise detail syllabus

Unit	Subject	Credit
Unit 1	Geoinformatics: Meaning and Scope of Geoinformatics -	1
	Science and Technologies involved: Cartography- Geodesy-	
	Geology- Remote Sensing- Geographical Information System-	
	Photogrammetry - Information & Communication	
	Technologies- Global Positioning System- Digital Image	
	Processing - Map as decision tool.	
Unit 2	Earth: Earth – Origin, Interior, Age, size, shape and	1
	Physiography of the Earth - Sources and methods of acquiring	
	geodata Atmosphere: Origin and nature, Composition and	
	layers of the atmosphere. Fundamental principles of acquiring	
	earth related information: geodetic information - lat - long -	
	time - altimetry – bio-physical and bio-chemical information.	
Unit 3	Basics Principles of Surveying: Basic principles of surveying	1
	- Classification and applications- Scales - Conventional signs	
	- Survey instruments, their care and adjustment - traversing,	
	trilateration and triangulation - conventional, electronic (total	
	station) - Aerial and Satellite based survey techniques	
	(Photogrammetry, RADAR, LiDAR) - Survey by GPS.	
Unit 4	Geodata Visualization: Geodata visualization and analysis -	1
	two – three – fourth dimension viewing - viewing by animation	
	- Visualization by hyper map - virtual images – web GIS.	

GINF 401: Introduction to Geoinformatics

1. Peter A. Burrough and Rachael A. Mc. Donnell, Principles of Geographical Information System, Oxford University Press Inc., New York, 2004.

- Ian Heywood, Sarah Cornelivs and Steve Carver, An Introduction to Geographical Information System, Pearson Education Pvt. Ltd., New Delhi, 2007.
- Arthur H. Robinson et al. Elements of Cartography, V Edition, John Wiley & Sons, New Delhi, 2002.
- 4. Lillesand M. Thomas and Ralph W. Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, New York, 2007.

GINF 402: Principles of Remote Sensing

Unit	Subject	Credit			
Unit – 1	Introduction To Remote Sensing: History and Concepts -	1			
	Advantages of Remote Sensing over Conventional Surveys -				
	Aerial versus Satellite Remote Sensing.				
	Electromagnetic Radiation: Physics of Remote Sensing -				
	Energy Sources - Radiation Principles - Energy Interaction				
	with Atmosphere - (Atmospheric Windows, Scattering,				
	Absorption) – Energy interaction with earth surface features				
	- (Absorption, Transmission, Scattering and Reflection).				
Unit – 2	Spectral Response Patterns: Spectral Reflectance of Earth	1			
	Surface Features in Different Wave Length Regions of EMR.				
Unit – 3	Platforms, Sensors & Orbits: Types and characteristics of	1			
	platforms & satellite orbits. Sensor classification: Active and				
	Passive, Optical-Mechanical Scanners & Push-broom				
	scanners, whisk broom scanners; Earth Resource Satellites,				
	Oceansat, LANDSAT, IRS Resourcesat and Cartosat,				
	Meteorological Satellites, INSAT, Ikonos Satellites Series,				

	Geoeye, Quickbird, RADAR, LIDAR, MODIS, NOAA and other platforms.			
Unit - 4	Visual Image interpretation and Applications: Visual	1		
	image analysis, elements of image interpretation,			
	interpretation keys, incorporation of ancillary and contextual			
	data, band selection, feature space, training signature			
	extraction, Land use / land Cover mapping, Agriculture,			
	Forestry, Hydrology, Urban and Regional Planning.			

- Anji Reddy, M. (2008): Textbook of Remote Sensing and Geographic Information System, B.S. Publication, Hyderabad
- 2. Drury, S. A. (2001): Image Interpretation in Geology, Blackwell, Oxford
- 3. Campbell, J. (2002): Introduction to Remote Sensing, Taylor & Francis, London
- 4. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey
- 5. Jensen, J.R., (2006) "Remote Sensing of the Environment An Earth Resources Perspective", Pearson Education, Inc. (Singapore) Pte. Ltd., Indian edition, Delhi.
- Joseph, G. (2004): Fundamentals of Remote Sensing, Universities Press, Hyderabad, India
- Sabins, F.F. Jr., (2007) Edition. 'Remote Sensing Principles and Interpretation'', W.H. Freeman & Co.
- 8. Reeves, Robert G. (1991), "Manual of Remote Sensing, Vol. I, American Society of Photogrammetry and Remote Sensing, Falls Church, Virginia, USA

GINF 403: Prin	ciples of Geo	graphical Infor	mation Systems
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Unit	Subject	Credit			
Unit – 1	Basic concepts: Definition and history of GIS, Meaning and	1			
	Usefulness of GIS, Components of GIS, Hardware, Software				
	Modules and Organisational Context of GIS.				
Unit – 2	Data Structure: Data Structure in GIS, Type of Data (Points,	1			
	Lines and Polygons)-Data Base Structures - Raster Data				
	Structures and Vector data Structures - Data Conversion,				
	(Vector to Raster and Raster to Vector).				
Unit-3	Data Input, Verification, Storage and Output: Data Input	1			
	Processes and Devices -Different Types of Entering Spatial				
	and Non-spatial Data - Data Verification -Correction -				
	Storage - Data output processes and devices.				
Unit - 4	Mapping Concept – Map Elements, Map scales and	1			
	representations, Map Projection, Geometric rectification,				
	Digitization, error identification. Errors: Types, sources,				
	correction. Editing and topology building. Map Output				
	Generation.				

- 1. Burrough, P. A. and McDonnell, R. A. (2000): Principles of Geographical Information Systems, Oxford University Press, New York.
- 2. Chang, K. T. (2008): Introduction to Geographic Information Systems, Avenue of the Americas, McGraw Hill, New York Longley.
- 3. Demers, M. N. (2000): Fundamentals of Geographic Information Systems, John Wiley and Sons, New Delhi.

- 4. Heywood, I., Cornelisus, S., Carver, S. (2011): An Introduction to Geographical Information Systems, Pearson Education, New Delhi.
- 5. Korte, G. B. (2001): The GIS Book, Onward Press, Bangalore
- 6. Lo, C. P., Yeung, A. W. (2002): Concepts Techniques of Geographical Information Systems, Prentice-Hall of India, New Delhi.
- P. A., Goodchild, M. F., Maguire, D. J., Rhind, D. W. (2002): Geographical Information Systems and Science, John Wiley & Sons, Chichester.

GINF 404: Principles and Applications Of GPS

Unit	Subject	Credit
Unit – 1	The Concept of Satellite Navigation, History, Satellite	1
	Navigations constellations - GPS system, GPS Segments -	
	Space Segment, Control Segment, Ground Segment, Geo-	
	Positioning-Basic Concepts. Different kinds of Navigation	
	Systems	
Unit – 2	Indian Regional Navigation Satellite System, GPS Aided	1
	GEO Augmented Navigation (GAGAN): Technology and	
	Applications, Navik and its Applications	
Unit – 3	Types of GPS Receiver, Static, Dynamic and Differential	1
	data processing, Velocity and Time Data, Position and	
	Height Transformation, Selective Availability, Ephemeris,	
	Multipath, Ionospheric & Tropospheric Delay, Dilution of	
	Position, Satellite & Receiver Clock Error.	
Unit - 4	Mobile GPS, Software Defined GPS and GPS -GIS	1
	Unification.	

- 1. Ahmed, E. L., Rabbany (2002): Introduction to Global Positioning System, Artech House, Boston
- 2. Bao, J., Tsui, Y. (2005): Fundamentals of Global Positioning System Receivers, John Wiley Sons, Inc., Hoboken
- 3. Bradford W. Parkinson & James Spilker., Global Positioning System: Theory and Applications, Vol I,1996
- 4. Gunter Seeber, (2003), Satellite Geodesy Foundations-Methods and Applications.
- 5. Hofmann W.B &Lichtenegger, H. Collins., Global Positioning System Theory and Practice, Springer-Verlag Wein, New York, 2001.
- 6. Kresse, W. and Danko, D. (2002): Springer Handbook of Geographic Information, Springer Drecht, London.

SEMINAR:

Course including GINF 401, 402, 403, 404

Presentation on a given topic and assignment submission.

GINF 405 PR: Geographic Information System

Course details	Credit
Introduction to GIS	2
Softwares: Introduction to ArcMap and ArcCatalog - Visualization of	
Geographic Datasets - Viewing properties - Basic ArcMap features	
(zoom – in, zoom out, pan etc.) - Symbology view and change	
Maps and Projections - Introduction to coordinate systems - Defining	2
geographic coordinate system - Projection to another - Importing	
coordinate systems - Projection of a text file.	
Viva voce.	

GINF 406 PR: Image Processing and GNSS

Course details	Credit	
Introduction to Software, Image Visualization Introduction to Image		
Processing Software -ENVI and SAGA Elements of Image		
Visualization and Feature Identification.		
Georeferencing - Adding extensions - Control point locations -		
Defining lat, long for an image - Georeferencing and rectification		
Image Processing - Raster Data Download - Layer Stacking -	2	
Mosaicking, Atmospheric and Radiometric corrections. Terrestrial		
Surveying Methods for Geospatial Data Collection and GPS Survey		
Introduction to GPS and initial setting Creating codes and attribute		
table for GPS receiver, GPS and GIS integrations output preparation.		
Viva voce		

Semester II

GEOINFORMATICS – THEORY and PRACTICAL

Course-wise detail syllabus

Unit Subject Credit Digital Data: Basic Characteristics of digital image - data Unit – 1 1 type and file format. Data acquisition and interpretation -Use of multiple images - multi-station – multi-band – multidate - multi-stage - multi-polarization - multi-direction multi-spectral. Digital Image Processing: Introduction - stages in digital Unit – 2 1 image processing. Pre-processing: geometric correction, atmospheric correction and radiometric correction - Image Enhancement: stretch, Single Band Enhancement (Image reduction & Magnification, Contrast Stretching, Filtering & Edge enhancement) - Multiband Enhancement (Band ratioing, colour composite generation, Principal Component Analysis, NDVI). Unit – 3 Unsupervised Classification: classification Image 1 Supervised classification technique - training sites classification stage - minimum distance to mean classifier parallelepiped classifier - maximum likelihood classifier -Hybrid Classification - Sub Pixel Classification - Fuzzy Classification - accuracy assessment. Unit - 4 Hyperspectral Image Processing: Data cube, Hyperspectral 1 Profiles, Data Redundancy - Problems with Dimensionality, Principal Component, Minimum Noise Fraction (MNF) -Atmospheric Correction, Pixel Purity Index, Empirical line

GINF 407: Digital Image Processing for Geoinformatics

Calibration -	Reflectance	Transformation,	Continuum	
Removal - Spe	ectral feature F	itting, Spectral An	gle mapper.	

- 1. Jensen R. John, Remote Sensing of the Environment An Earth Resource Perspective, Pearson Education Pvt. Ltd., Delhi, 2006.
- 2. Gibson, Paul.J. and Clare H. Power, Introductory Remote Sensing: Digital Image Processing and Applications, Routledge, London, 2000.
- 3. Milman S. Andrew, Mathematical Principles of Remote Sensing making Inferences from Noisy Data, Ann Arbor Press, Noida, 1999.
- 4. Paul J. Curran, Principles of Remote Sensing, English Language Book Society, Longman, 1985.
- 5. John A. Richards, Springer-Verlag, Remote Sensing Digital Image Analysis, 1999.
- 6. Digital Image Processing (3rd Edition) Rafael c.Gonzolez,
- 7. Richard E.Woods Prentice Hall, 2007.

GINF 408: WEB PROGRAMMING

Unit	Subject	Credit		
Unit – 1	Basics of Internet: Hardware Components, Protocols,	1		
	Browsers, Mail Clients, Web Servers, Mail Servers			
	HTML Fundamentals: Text Formatting Tags, Physical			
	Tags, Forms Tags, Table Tags, Frame Tags etc.			
	DHTML Fundamentals: Introduction to DHTML,			
	Introduction to CSS, Creating and Managing Styles,			
	Website Layout and Design.			

Unit – 2	Introduction to JavaScript: Difference between Client-Side	1
	Vs Server-Side JavaScript Fundamental JavaScript	
	Directives Server-Side JavaScript Java Script Objects.	
	Open-Source: Introduction to Open Source, Advantages and	
	Capabilities of Open Source, PHP Vs JSP and ASP	
	Adding PHP to HTML, Introduction to Apache	
	Applications of Open Source like Drupal, WordPress, Cake	
	PHP (CMS, Joomla, MVC) etc.	
Unit – 3	PHP Programming: Syntax and Variables Control and	1
	Functions, Arrays, Array and String Functions, Regular	
	Expression, Passing information between pages.	
Unit - 4	Working with MySQL, Configuring PHP for Database	1
	Introduction to MySQL MySQL functions, Executing	
	System Calls (Select Insert Fetch Undate Delete)	
	System Cans (Sereet, msert, Teten, Opuate, Derete)	
	Database Connectivity, Retrieving Data from Forms	
	Database Connectivity, Retrieving Data from Forms Introduction to Session and Cookies.	

- 1. Ivan Baryons: HTML, DHTML, JavaScript, CGI & Perl
- 2. O'reilly Publication: PHP Cookbook
- 3. Wiley Publication: PHP and MySQL

GINF 409: JAVA Programming

Unit	Subject	Credit
Unit – 1	Introduction to Java: Origin & Features of Java language	1
	Java development Kit & Java packages Class, Object,	
	Memory management, Polymorphism in Java, Inheritance,	
	Overloading and overriding in Java.	
	Advanced Programming Concepts	
	Exception handling, I/O & File management	
	Multithreading, JDBC	
Unit – 2	Implementation Advanced Programming Concepts	1
	using Visual Programming: Introduction Event handling	
	Visual programming using AWT Advanced Visual	
	programming using JFC	
Unit – 3	Web Programming: Applets design Servlets / JSP	1
	Network programming	
Unit - 4	Advanced Concepts-I & II: Java Beans RMI & CORBA	1
	Java mail API	

- 1. Patrick Naughton: Complete Reference TMH
- 2. Daniel Joshi and Paul Vorobeiu: The Java 1.1 Programmer Comdex Times
- C. Thomas: Introduction to Object Oriented Programming with Java -TMH, Naughton: The Java Hand Book – TMH

GINF 410: Spatial Database and Modelling

Unit	Subject	Credit
Unit – 1	Introduction to SQL: Definition, purpose, data abstraction, instances, schema, database manager, database administrator Normalization (1NF, 2NF, 3NF forms) Data definition manipulation using SQL, SQL query processing, operations on tables, integrity constraints.	1
Unit – 2	Data Models: Geo-relational Model – Vector Data structure, Advantages & Disadvantages, Non-spatial: Hierarchical structure, Network structure, Relational Structure, Spatial Data Bases: Hybrid Data Model, Integrated Data Model.	1
Unit – 3	Data Quality: Applets design Servlets / JSP Network programming Types of uncertainty in a GIS: Obvious sources from natural variations & Original measurements, Data Quality parameters (Positional accuracy, Attribute accuracy, Logical consistency, Completeness Lineage).	1
Unit - 4	Data Errors in GIS:Handling Errors in GIS,Normalization in GIS, Levels of Measurements:Nominal, Ordinal, Ratio and Interval.	1

 Silberschats, Henry F. Korth (1998) "Database System Concepts", 3rd Edition, TMH, Bonham Carter G.F (1994) GIS for Geoscientists: Modeling with GIS Pergamon Publications.

- Goodchild, M.F. (1978) Statistical Aspects of the Polygon Overlay Problems, in Harvard papers on GIS, Ed. G. Dulton, Vol. 6, Addison Wesley and Reading Press.
- 3. Mary Summer, Computers: Concepts and Uses, Prentice Hall, Englewood Cliffs. New Jersey.
- 4. Mac Donald, A. 1999, Building a Geodatabase, Redlands CA: ESRI Press. Sanghavi, Hitesh (1998) Oracle Miracles, Express computers methods, 1998.
- 5. Samet, H. 1990, The Design and Analysis of Spatial Data Structures, Addison–Wesley.

SEMINAR:

Course including GINF 407, 408, 409, 410

Presentation on a given topic and assignment submission.

GINF 411 PR: Remote Sensing, Digital Image Processing and Photogrammetry

Course details	Credits
Multiband Image Enhancement: Band ratios, Colour composite generation, Principal component analysis, Image Classification: Supervised and Unsupervised classification.	2
Photogrammetric Techniques: Stereo image analysis. Orthorectification using DEM, 3D feature extraction, Hyperspectral Data processing: Pixel purity Index (PPI), MNF, Spectral angle mapper, Continuum removal.	2
Viva voce.	

GINF 412 PR: Web & JAVA Programming

Course details	
Wb design: CSS-based responsive design, JavaScript for client-side	
interactivity. PHP & MySQL Integration: Form handling with	
validation, CRUD operation with spatial tables, Session handling and	
user authentication. Web GIS Conceptual Integration: Display	
coordinates or location-based data on basic web interface	
Java Programming: Implement basic OOP concepts using real-	
world entities, Design GUI form for entering coordinates/locations.	
JDBC with MySQL: Connect to a MySQL spatial table using	
JDBC. Visual and Network Programming: GUI forms using swing.	
Query and filter data based on attribute values.	
Viva voce.	