M.Tech. Geoinformatics

(2022 – 2024)

REGULATIONS
&
CURRICULUM STRUCTURE

BHARATHIDASAN UNIVERSITY

TIRUCHIRAPPALLI – 620 024

PH: 0431-2407079

EMAIL: GEG@BDU.AC.IN

M.TECH. GEOINFORMATICS PROGRAMME

Choice Based Credit System [CBCS]

Regulations and Syllabus (2022-2024 onwards)

REGULATIONS & SYLLABUS

(2022-2024)

PROGRAMME

M.Tech., Geoinformatics is an autonomous programme through **C**hoice **B**ased **C**redit **S**ystem [CBCS] offered by the Department of Geography, Bharathidasan University. During the course of study, the candidates will have an opportunity for a strong exposure to the concepts in Geoinformatics and also to the advanced level of applications.

ELIGIBILITY

P.G. in Geography / Applied Geography / Geology / Applied Geology / Geoinformatics / Spatial Information Technology / Environmental Sciences / Agriculture / Forestry or B.E. / B.Tech. Civil Engineering / Agricultural Engineering / Geoinformatics degree or an examination of other University accepted by the Syndicate of this University as equivalent

DURATION OF THE PROGRAMME

Total duration of the programme:	Two academic years
Number of semesters in each Academic Year:	Two
Odd semester:	July - November
Even semester:	December - April

EXAMINATION

Examination will be conducted at the end of each semester. A candidate who fails in a course or courses can reappear for the same in the subsequent semesters. A candidate failing in the dissertation shall be required to resubmit his work in the next semester. The curriculum structure gives a detailed account of the scheme of courses.

Students must have 75 percent of attendance in each Course for appearing the examination. Students who have 74 percent to 70 percent of attendance shall apply for condonation in the prescribed form with the prescribed fee. Students who have 69 percent to 60 percent of attendance shall apply for condonation in prescribed form with the prescribed fee along with the Medical Certificate. Students who have below 60 percent of attendance are not eligible to appear for the examination.

A candidate who fails in a theory course or courses can reappear for the same in the subsequent semester(s). However, candidates who have arrears in practical courses shall be permitted to take their arrear practical examination only along with regular practical examination in the respective semester. A candidate failing in the dissertation shall be required to resubmit his work in the next semester.

EVALUATION

The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to grade points. Evaluation for each course shall be done by a Continuous Internal Assessment (CIA) by the concerned Course Teacher as well as by an End Semester Examination (ESE) and will be consolidated at the end of the programme. Out of 100 marks in each course, 25 per cent of marks are for Continuous Internal Assessment and 75 per cent for University

End Semester Examinations. The components for Continuous Internal Assessment are: a) Internal Test, b) Seminar, c) Assignment, d) Interaction and e) Attendance.

PASSING MINIMUM OF MARKS

A candidate has to secure not less than 45 per cent of the marks in the End-Semester Examination (ESE) and 50 per cent of the marks in the aggregate of the marks secured in the Continuous Internal Assessment (CIA) and the End-Semester Examination (ESE) in each of the courses including practical.

A candidate shall be declared to have passed in the Dissertation if he/she gets not less than 40 percent in the Dissertation and Viva-voce but not less than 50 percent in the aggregate of both the marks for Dissertation and Viva-voce. A candidate who gets less than 40 percent in the Dissertation must resubmit the Dissertation. Such candidates need to take again the Viva-Voce on the resubmitted Dissertation.

PATTERN OF QUESTION PAPER

The question paper in each course would comprise of Part A, Part B and Part C.

- Part-A Students have to answer 10 questions (10 X 2 = 20 marks)
- Part-B There will be 5 questions in either or pattern (5 X 5 = 25 marks)
- Part-C Two out of three questions have to be answered (2 X 15=30marks)

STATEMENT OF MARKS AND PROVISIONAL DEGREE CERTIFICATE

The final consolidated statement of marks and provisional degree certificate will be signed and issued by the Controller of Examinations, Bharathidasan University.

CONFERMENT OF THE DEGREE

A candidate shall be eligible for the conferment of the degree after he /she has passed all the examinations prescribed to the programme including the labs and dissertation.

REVISION OF REGULATION AND SYLLABUS

The Department Committee may from time to time scrutinize and change the regulations and the syllabus as and when necessary. However, the Department follows other general guidelines of the University, which are not laid down in this regulation.

SPECIAL FEATURES

1. Weekly seminar for the students with recent and trending topics.
2. Scheduling weekly tests for the students.
3. Library facilities including digital satellite and statistical data.
4. Availability of hard copy and digital topographic sheets and OSM sheets.
5. Licensed ESRI ArcGIS & ArcGIS Pro software's.
6. Surveying instruments such as DGPS and Total Station.
7. Ground Penetrating Radar (GPR) for field survey.
8. Educational field trips.
9. Industrial Visits.

Program Outcomes

- The M.Tech graduates are **Professionally Competent** with characteristic **Knowledge-bank, Skill-set, Mind-set** and **Pragmatic Wisdom** in their chosen fields.
- M.Tech graduates demonstrate the desired sense of being **seasoned** and exhibit unequivocal **Spiritedness** with excellent qualities of productive contribution to **society** and **nation** in the arena Science and Technology.
- The graduates are mentored such that they exert **Leadership Latitude** in their chosen fields with **commitment to novelty** and **distinction**.
- The graduates are directed in understanding of ethical principles and responsibilities, moral and social values in day-to-day life thereby attaining **Cultural** and **Civilized** personality.
- The graduates are able to **collate** information from different kinds of sources and gain a coherent understanding of the subject.

Program Specific Outcomes

1. To create solutions to manage and process spatial information and proficiently interact with group of experts in various fields.
2. Work in operational, technical or executive positions related to Geoinformatics in governmental agencies, universities, research centres, the private sector, and multinational corporations.
3. Students who have completed their M.Tech in Geoinformatics can be employed as GIS consultants, GIS managers, GIS Engineers, GIS analysts or GIS developers.
4. This programme makes the students can be fully equipped with concepts, methodologies and applications of Remote Sensing Technology, GIS and GNSS.
5. Acquire skills in handling instruments, tools, techniques and modelling while using Remote Sensing Technology
6. Empowers the candidate with confidence and leadership qualities.
7. Enable to acquire skills in advance techniques such as hyper spectral, thermal and LiDAR scanning for mapping, modelling and monitoring.
8. Familiarises in storing, managing digital data for planning and development.

Department of Geography

Bharathidasan University, Tiruchirappalli 620 024

M.Tech., GEOINFORMATICS

CURRICULUM STRUCTURE

(2022-2024 Onwards)

Sem	Course Code	Course Title	Credits	Instruction Hrs/week			Exam Hrs	Marks		Total
				TH	TU	PR		CIA	ESE	
I	22CC01	Remote Sensing	4	3	1		3	25	75	100
	22CC02	Digital Cartography	4	3	1		3	25	75	100
	22CC03	Geographical Information System	4	3	1		3	25	75	100
	22EC01	Elective I	3	3			3	25	75	100
	22EC02	Elective II	3	3			3	25	75	100
	22CC04	Remote Sensing Lab	3			4	3	40	60	100
	22CC05	GIS and GNSS Lab	3			4	3	40	60	100
	22CC06	Global Navigation Satellite System	4	3	1		3	25	75	100
		Credits	**28**							
II	22CC07	Digital Photogrammetry	4	3	1		3	25	75	100
	22CC08	Microwave and Hyperspectral Remote Sensing	4	3	1		3	25	75	100
	22CC09	Digital Image Processing	4	3	1		3	25	75	100
	22EC03	Elective III	3	3			3	25	75	100
	22EC04	Elective IV	3	3			3	25	75	100
	22CC10	Photogrammetry and Image Processing Lab	3			4	3	40	60	100
	22CC11	GIS Customization Lab	3			4	3	40	60	100
	22CC12	Spatial Database Management	4	3	1		3	25	75	100
	VAC-I	Java Script Programming	2	-	-	-	-	25	75	100
		Credits	**30**							
III	22CC13	Watershed Studies	4	3	1		3	25	75	100
	22CC14	Disaster Studies	4	3	1		3	25	75	100
	22CC15	Urban Studies	4	3	1		3	25	75	100
	22EC05	Elective V	3	3			3	25	75	100
	22EC06	Elective VI	3	3			3	25	75	100
	22CC16	Resources Evaluation Lab	3			6	3	40	60	100
	22CC17	Mini Project & Viva Voce	3			6	3	40	60	100
	22CC18	Research Ethics, Project Management and IPR	4	3	1		3	25	75	100
	VAC-II	GIS-Supply Chain Visualization & Analysis	2	-	-	-	-	25	75	100
		Credits	**30**							
IV	22CC19	Dissertation & Viva Voce	20		30			50	150	200
		Credits	**20**							

MINIMUM CREDITS OF THE PROGRAMME: 108

List of Elective Courses Offered

	Elective Courses	Teaching Hours	Credits
1.	C++ Programming	3	3
2.	Statistics for Data Science	3	3
3.	Spatial Analysis	3	3
4.	Global Navigation Satellite System	3	3
5.	Earth System Science	3	3
6.	Coastal Zone Studies	3	3
7.	Python Programming	3	3
8.	.NET Programming	3	3
9.	Java Programming	3	3
10.	Decision Support System	3	3
11.	Natural Resources Management	3	3
12.	Web GIS	3	3
13.	Research Ethics, Project Management and IPR	3	3
14.	Advances in Geospatial Technologies	3	3
15.	Regional Planning	3	3
16.	Project Management	3	3
17.	Mapping Beyond Earth	3	3
18.	Environmental Studies	3	3

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester I	
Course Code / Title	**22CC01 - REMOTE SENSING**	

Objectives

1. *To introduce the students about the principles of Remote Sensing and image acquisition systems*
2. *To aware the basic and modern photogrammetric methods*
3. *To familiarize the concepts and resolutions of different remote sensing imaging systems and its applications*
4. *To understand the principles of thermal imaging and its applications*

Unit 1:	**Remote Sensing System:** Elements of EMR - wavelength regions – energy interaction in atmosphere – absorption – scattering - atmospheric windows – terrestrial interaction – spectral reflectance curves – active and passive remote sensing - Indian remote sensing centers and their activities – new satellite programs of India - National Geospatial Policy (India) - governing remotely sensed data.
Unit 2:	**Aerial Remote Sensing:** Brief history of aerial remote sensing - principles of photography - resolution - optical axis - camera and films: types and uses - Parts of camera: frame and digital Camera - analogue and digital products, UAV – Types – Imaging technique - Photogrammetry: Errors in aerial photography – stereo vision - scale – relief displacement and parallax –elements of photo interpretation – flight planning.
Unit 3:	**Satellites and Sensors:** Types of satellites – platforms – payload – satellite characteristics: orbits and swaths – scanning methods: Image & Video – FOV and IFOV - resolution: spatial, spectral, radiometric and temporal – hyper spectral sensors and imaging - pixel size and scale.
Unit 4:	**Remote Sensing Satellites:** Orbit - sensor characteristics and applications of Weather satellites: GOES, NOAA, METEOSAT, INSAT - Land observation satellites: LANDSAT, SPOT, IRS, IKONOS, GEOEYE, WORLDVIEW, SENTINEL – SkySat - Dove - RapidEye - Marine observation satellites: Seasat, Nimbus: CZCS, MOS, Sea Star: SeaWiFS, Oceansat.
Unit 5:	**Thermal Remote Sensing**: Planck's blackbody law – displacement law and emissivity effects - heat capacity, thermal conductivity - thermal inertia – diurnal heat effects – thermal property of objects – thermal sensors – thermography – thermal image interpretation.

Unit 6: Current Contours: Not for Examination Only for Discussion

Video imaging satellites, Real Time Observations, Unmanned Aerial Vehicles, Light weight Satellites

References:

1. Wolf. P.R., (2014). Elements of Photogrammetry with Application in GIS, McGraw Hill books Co., London.
2. Curran P.J (1985). Principles of Remote Sensing, Longman, London.
3. Lillisand T.M and R.W. Kiefer (1994). Remote Sensing and Image Interpretation (3rd edition). John Wiley & Sons, New York.
4. Sabins F.F Jr. (1987). Remote Sensing: Principles and Interpretation, W.H.Freeman & Co., New York.
5. James B. Campbell, Randolph H. Wynne, Valerie A. Thomas (2022). Introduction to Remote Sensing, Guilford Press, New York
6. Alexey Bunkin and Konstantin Voliak (2001). Laser Remote Sensing of the Ocean, John Wiley and Sons., New York.
7. Gibso, P., and Clare H. Power, (2000). Introductory Remote Sensing: Principles and Concepts, Routledge, London.
8. Hayesm L., (1991). Introduction to Remote Sensing, Taylor and Francis Publication, London.
9. Kumaraswamy, K. (2003). Remote Sensing for Environmental Studies, Department of Geography, Bharathidasan University, Tiruchirappalli.
10. Karl Kraus (2007). Photogrammetry – Geometry from Images and Laser Scans, Walter de Gruyter, Berlin.

Web References:

1. www.rst.gsfc.nasa.gov
2. www.ccrs.nrcan.gc.ca/resource/tutor/fundam/index_e.php
3. http://www.nrsc.gov.in
4. www.isro.org
5. http://iirs.gov.in

Course Outcomes:

Students will be sable to:

1. Discuss the principles and development of remote sensing and its National and International scenario.
2. Describe the principles and applications of aerial remote sensing data acquisition methods and its uses.
3. Illustrate the scale, relief displacement and parallax of aerial photographs.
4. Differentiate the analogue and digital products of remote sensing.
5. Articulate the concepts of orbits, platform and different scanning mechanisms.
6. Increase the proficiency of understanding the concepts of various types of resolutions in satellite remote sensing.
7. Discuss the characteristics of land and marine observation satellites.
8. Understand of thermal remote sensing and principles.
9. Acquire knowledge on applications of thermal remote sensing in various domains.
10. Master to handle different satellite data products

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester I	
Course Code / Title	**22CC02 – Digital Cartography**	

Objectives

1. *The course would discuss the basic concepts of Digital Cartography*
2. *The concepts of map construction and production are taught.*
3. *Students would acquire the knowledge about the usage of conventional signs and symbols to interpret the various topographic maps.*
4. *Acquire knowledge on Spatial data analysis and visualization on digital platforms*

Unit 1:	**Maps and Scale**: Map - types of maps - interpreting maps - map scale: plain linear, statement, diagonal and comparative, representative fraction.
Unit 2:	**Map Projections:** General principles of map projections – classification – cylindrical, conical, and zenithal projections – coordinate systems - UTM – choice of projections.
Unit 3:	**Map Layout and Map Production:** Data acquisition –Spatial and Non-Spatial Data - Mechanics of map construction -Map design and layout - map reproduction methods: tradition and modern - Cartographic Publication
Unit 4:	**Modern Cartography:** Theories - Geodata Infrastructures - Geovisualization - Visual Data Analytics - Location based services - Multimedia Cartography - Georelief - Mobile Cartography
Unit 5:	**Applied Cartography:** Terrain Visualization - Multivariate and Uncertainty Visualization - Multiscale web mapping - Research and development

Unit 6: Current Contours: Not for Examination Only for Discussion

Cartographic display; Cartography and GIS; Democratization of Cartography; Mobile Cartography; Virtual Mapping

References:

1. Robinson, A.H. et al. (1995) Elements of Cartography, John Wiley & Sons, U.S.A.
2. Kenneth Field, (2018). Cartography: A Compendium of Design Thinking for Mapmakers, ESRI Press
3. Misra, R.P. and Ramesh, A. (1986) Fundamentals of Cartography, Concept Publishing Company, New Delhi.
4. Kraak M.J. (2010) Cartography: Visualization of Geospatial Data (3rd edition), Pearson Education Ltd., London.
5. Monkhouse, F.J. and Wilkinson, H.R. (1994) Maps and Diagrams, Methuen, London.
6. Sarkar A. K. (1997) Practical Geography: A Systematic Approach, Oriental Longman, Calcutta.
7. Singh, R.L. and Dutt, P.K. (1979) Elements of Practical Geography, Kalyani Publishers, New Delhi.
8. Michael Law (2021) Getting to Know ArcGIS Pro 2.8 Fourth Edition, ESRI Press, U.S.A
9. Burrough, P.A., and McDonnell, R.A., (2012), Principles of Geographic Information Systems, Oxford University Press.
10. Heywood, I. et al., (2004) An Introduction to Geographic Information Systems, Pearson Education.

Web References:

1. *www.esri.com*
2. *www.natmo.gov.in*
3. *www.surveyofindia.gov.in*
4. *www.gsi.gov.in*
5. *www. nbsslup.icar.gov.in*

Course Outcomes:
Students will be able to:

1. Familiar with the map types and scale.
2. Understand principles and application of projection systems
3. Acquire knowledge visualize, the spatial data.
4. Describe the methods and application of information delivery and cartographic presentation on mobile devices.
5. Gain knowledge to explore the spatial and non- temporal datasets with data mining.
6. Handle modern techniques in map making and production
7. Explore the multi-scale web mapping.
8. Asses the spatial arrangement various entities for effective mapping.
9. Visualize multivariate spatial data
10. Understand web mapping and hosting principles

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester I	
Course Code / Title	**22CC03 – Geographic Information System**	

Objectives

1. *To introduce the concepts of spatial data and methods of representation*
2. *To provide an overview of various types of GIS data model*
3. *To display various data input methods, storage and editing*
4. *To introduce the concepts of DBMS and entity modeling*

Unit 1:	**Introduction:** Nature of GIS – Real world and representations: Modelling, Maps, Databases and Spatial Databases - Geographic phenomena: fields, objects and boundaries - Data types: nominal, ordinal, interval and ratio - Attribute data.
Unit 2:	**Data Representation**: Tessellations and vector approaches - Topology and spatial relationships - Scale and resolution - Representations of geographic fields and objects - Temporal dimension.
Unit 3:	**Data Management**: GIS software - Spatial Data Infrastructure - Spatial data handling - Database management systems – GIS and spatial databases **-** Data Input: Spatial data input –Data quality - Data preparation – Point data transformation - Error propagation.
Unit 4:	**Spatial Data Analysis:** Retrieval, classification and measurement – Overlay functions - Neighbourhood functions - Network analysis – Surface analysis - Spatial autocorrelation - GIS and application models - Spatial data mining.
Unit 5:	**Data Visualization and Recent Trends:** GIS and maps - Visualization process - Visualization strategies - Cartographic techniques **–** Maps dissemination - Process modelling and simulation - Geographic Visualization: Socio-economic thematic maps, The dimensions of spatial data: 2D, 2.5D, 3D and 4D GIS, Current Issues and Trends in GIS

Unit 6: Current Contours: Not for Examination Only for Discussion

Hydrological modelling - Land-surface process modelling - Environmental information system development - Ecosystem modelling - Risk and hazard modelling - Integrated modelling - Web GIS - Mobile GIS

References:

1. C.P.Lo. Albert K.W Yeung (2012) Second Edition Concept and Techniques of geographic Information System, PHI Learning private limited New Delhi
2. Burrough, P.A., and McDonnell, R.A., (2012), Principles of Geographic Information Systems, Oxford University Press.
3. Chang, K. T., (2006), Introduction to Geographic Information Systems, Tata McGrawHill.
4. De Mers, Michael N., (1999), Fundamentals of Geographic Information Systems, John Wiley & Sons.
5. Heywood, I. et al., (2004): An Introduction to Geographic Information Systems, Pearson Education.
6. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W., (2001), Geographic Information Systems and Science, Wiley.
7. Maguire, D.J., Goodchild, M.F., and Rhind, D.W., (1991), Geographic Information Systems, Longman Scientific and Technical.
8. Michael Law (2021) Getting to Know ArcGIS Pro 2.8 Fourth Edition, ESRI Press, U.S.A
9. Wolf, P. R., and Dewitt, B. A., (2000), Elements of Photogrammetry: With Applications in GIS, McGraw-Hill.
10. Konecny, G., (2014), Geoinformation: Remote Sensing, Photogrammetry, and Geographic Information Systems (2nd Edition), CRC Press.

Web References:

1. *www.esri.com*
2. *www.natmo.gov.in*
3. *www.surveyofindia.gov.in*

Course Outcomes:

Students will be able to:

1. Understand the Fundamentals of GIS.
2. Distinguish Various types of GIS data models.
3. Familiarization with various data types, editing and storage of spatial and non-spatial data.
4. Create maps, images, and apps to communicate spatial data in a meaningful way to others
5. Demonstrate organizational skills in file and database management.
6. Clarify the concepts and components of DBMS and entity modelling
7. Explore the data mining and data marts.
8. Apply basic graphic and data visualization concepts such as color theory, symbolization, and use of white space.
9. Visualize multivariate spatial data
10. Understand web mapping and hosting principles

Programme	M.Tech., Geoinformatics	Credits: 03
	Semester I	
Course Code / Title	22CC04 - Remote Sensing Lab	

Objectives

1. *Learn aerial and satellite image metadata*
2. *Determine feature measurements in aerial and satellite images*
3. *Learn image interpretation keys*
4. *Map and Interpret physical and cultural features from the aerial and satellite images*

Unit 1:	Lab 1: Study of marginal information of aerial photographs. Lab 2: Study of marginal information of satellite images. Lab 3: Stereo vision test and stereoscopic viewing through stereoscopes.
Unit 2:	Lab 4: Determination of scale of vertical photographs. Lab 5: Determination of height of the object using parallax bar.
Unit 3:	Lab 6: In- depth study of visual interpretation keys. Lab 7: Comparison of True Colour, False Colour and Panchromatic photographs.
Unit 4:	Lab 8: Study of aerial photographs for mapping physical features. Lab 9: Study of aerial photographs for mapping cultural features.
Unit 5:	Lab 10: Study of satellite images for mapping physical features Lab 11: Study of satellite images for mapping cultural features

Unit 6: Current Contours: Not for Examination Only for Discussion

Automatic Geometric Correction, generation of ortho photos, elevation extraction, computation of parallax.

References:

1. Lillisand. T.M., and Kiefer, P.W., (1998) Remote Sensing and Image Interpretation, John Wiley & Sons, New York.
2. Moffit, H. F., and Edward, M. M., (1980). Photogrammetry, Harper and Row Publishers, New York.
3. Wolf, P. R., (1974). Elements of Photogrammetry, McGraw Hill books Co., London.
4. Rampal. K.K (1999) Hand Book of Aerial Photography and Interpretation, Concept Publishing Company, New Delhi.
5. American Geological Institute (1968) Stereo Atlas, Earth Science Curriculum Project, American Geological Institute, Hubbard, Illinois.
6. Karl Kraus (2007) Photogrammetry – Geometry from Images and Laser Scans, Walter de Gruyter, Berlin.
7. Leica Geosystem GIS & Mapping, (2009). Leica Photogrammetry Suite OrthoBASE & OrthoBASE Pro Users Guide, Atlanta.
8. James B. Campbell, Randolph H. Wynne, Valerie A. Thomas (2022). Introduction to Remote Sensing, Guilford Press, New York
9. Gibso, P., and Clare H. Power, (2000). Introductory Remote Sensing: Principles and Concepts, Routledge, London.
10. Hayesm L., (1991). Introduction to Remote Sensing, Taylor and Francis Publication, London.

Web References:

1. www.hexagongeospatial.com
2. www.nrsc.gov.in
3. https://www.geo.university/courses/introduction-to-remote-sensing
4. https://www.nrcan.gc.ca/maps-tools-and-publications/satellite-imagery-and-air-photos/tutorial-fundamentals-remote-sensing/9309
5. https://onlinecourses.nptel.ac.in/noc21_ce61/preview

Course Outcomes:
Students will able to:

1. Distinguish various data about aerial and satellite images
2. Understand the working principle of stereoscopes
3. Determine feature height and length using aerial and satellite images
4. Measure features using parallax bar
5. Acquire knowledge in interpretation keys and techniques to read images
6. Distinguish different bands of spectrum used in images
7. Distinguish physical and cultural features from aerial photos
8. Identify physical and cultural features from satellite images
9. Interpret earth surface feature in an aerial photograph
10. Interpret earth surface features in a satellite image

Programme	M.Tech., Geoinformatics	Credits: 03
	Semester I	
Course Code / Title	**22CC05 - GIS and GNSS Lab**	

Objectives

1. *Learn the concepts of GIS*
2. *Understand the design principles of Spatial data structure*
3. *Learn spatial data visualization techniques*
4. *Collect data using GPS and Total station*

Unit 1:	Lab 1: Introduction to GIS Software Lab 2: Structuring Geographic Data Lab 3: Explore Spatial and Attribute Data
Unit 2:	Lab 4: Spatial Referencing Lab 5: Digitizing and Editing Geographic Data Lab 6: Map Symbolization
Unit 3:	Lab 7: Spatial Data Visualization Lab 8: Point Data Interpolation Lab 9: Spatial Analysis with Vector Data
Unit 4:	Lab 10: Spatial analysis with Raster Data Lab 11: Field Data Collection and Mapping
Unit 5:	Lab 12: DGPS Survey and Post Processing Lab 13: Total Station Instrument Survey

Unit 6: Current Contours: Not for Examination Only for Discussion

Open-source software, Integration of spatial data in recent world

References:

1. Willpen L. Gorr and Kristen S. Kurland, (2011). GIS Tutorial 1: Basic Workbook for ArcGIS10, ESRI Press, Red Lands, USA.
2. David W. Allen, (2011). GIS Tutorial 2: Spatial Analysis Workbook for ArcGIS10, ESRI Press, Red Lands, USA.
3. David W. Allen and Jeffery M. Coffey, (2011). GIS Tutorial 3: Advanced Workbook for ArcGIS10, ESRI Press, Red Lands, USA.
4. Andy Mitchell, (1999). GIS Analysis - Volume 1: Geographic Patterns and Relationships, ESRI Press, Red Lands, USA.
5. Andy Mitchell, (2009). GIS Analysis - Volume 2: Spatial measurements and Statistics, ESRI Press, Red Lands, USA.
6. Hofmann – Wellenhof, Lichtenegger, and Wasle, (2008). Global Navigational Satellite Systems Springer Wien, New York.
7. Ghilani, C.D. and Wolf, P.R. (2012). Elementary Surveying: An Introduction to Geomatics, 13th Edition, Prentice Hall, New York.
8. Jan Van Sickle, (2008). GPS for Land Surveyors, CRC Press, New York.
9. Michael Law (2021) Getting to Know ArcGIS Pro 2.8 Fourth Edition, ESRI Press, U.S.A
10. Wolf, P. R., and Dewitt, B. A., (2000), Elements of Photogrammetry: With Applications in GIS, McGraw-Hill.

Web References:

1. www.nrsc.gov.in
2. https://bhuvan.nrsc.gov.in/
3. www.esri.com
4. https://www.qgis.org/en/site/
5. https://www.geo.university/collections/gis

Course Outcomes:
Students will able to:

1. Understand the spatial data structure
2. Distinguish geometrical and attribute data
3. Understand the principles of representation of spatial data in computers
4. Perform data creation and visualization tasks
5. Perform single layer operations/analysis
6. Perform multi-layer operations/analysis
7. Collect real time data using GPS and total station
8. Perform data import and manipulation of real time data
9. Create models to seamlessly perform GIS analysis
10. Create map layouts to visualize results

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester I	
Course Code / Title	**22CC06 – Global Navigation Satellite System**	

Objectives:

1. *Demonstrate a clear understanding of the GPS signal, codes and biases*
2. *Discuss the practical applications of GPS and the implications of its modernization*
3. *Explain the difficulties in determining heights with satellite positioning and how they can be overcome*
4. *Describe the differences between relative and autonomous GPS positioning, code phase carrier phase, DGPS and RTK.*

Unit 1:	**Introduction:** Historical development - Conventional navigation, background, concepts and evolutions of global navigation satellite systems (GPS, GLONASS, Galileo, BeiDou/ COMPASS) and regional navigations satellite systems (IRNSS, QZSS). Comparison of GNSS with other navigation systems; various GPS software products and peripherals System overview - Space Segment - GPS Satellite Systems – new programmes - Control Segment - satellite tracking - User segment – land navigation - marine navigation - survey instruments - Recent trends
Unit 2:	**Working Principles of GPS:** Satellite ranging - resection; error sources atmospheric - Ionospheric errors – multipath - Selective availability - antispoofing error rectification - atmospheric and Ionospheric models –choke ring - differentially corrected positions; Positioning techniques - precise point positioning; - Satellite geometry - mask and azimuth angles - Differential Global Navigation Satellite System (DGNSS), Satellite Based Augmentation System (SBAS).
Unit 3:	**Geodesy and Surveying:** Geodesy - meaning and application - geoid, spheroid and ellipsoid of revolution, use of gravity in geodesy, coordinate system, geodetic reference systems, - GNSS – GPS coordinate system – Local Coordinate system – transformations – step wise transformation – seven parameter transformation; Measuring techniques – Static surveys –- rapid static survey – kinematic survey – RTK survey – Pre survey preparations – Total Station.
Unit 4:	**GNSS and GIS Integration:** Integration techniques - Data focused integration, position focused and technology focused integration; Technology convergence for data use; Methods of integration - NAME, Binary Data control and customization — Active X; Hardware and software platforms; GPS, GIS.
Unit 5:	**GNSS Applications:** Location - Navigation - Tracking - Mapping and Tinning - Misuses of GNSS - types of misuses - examples - Intelligence collection augmentation with weapon system, integration into ballistic and cruise missile systems; Future uses – position information society - consumer based GNSS products.

Unit 6: Current Contours: (For continuous internal assessment only)

IRNSS, Challenges of GNSS, Future Positioning Satellites, Real Time Tracking, Low Altitude Tracking Systems.

References

1. Hofmann – Wellenhof, Lichtenegger, and Wasle, (2008). Global Navigational Satellite Systems *(GNSS)* Springer Wien New York.
2. F. van Diggelen. A-GPS, Assisted GPS, GNSS, and SBAS, Artech House, Boston, London, 2009 Earth-prints. Internet repository of scientific papers.
3. Basudeb Bhatta (2021). Global Navigation Satellite Systems: New Technologies and Applications, CRC Press, India
4. Lu, Zhiping, Qu, Yunying, Qiao, Shubo (2014) "Geodesy: Introduction to Geodetic Datum and Geodetic Systems"
5. Torge, Wolfgang / Müller, Jürgen (2012) "Geodesy".
6. Mohinder S. Grewal, Angus P. Andrews, Chris G. Bartone, (2020).Global Navigation Satellite Systems, Inertial Navigation, and Integration, 4th Edition
7. Agraval, N. K., (2006). Essentials of GPS, Geodesy and GPS publications, Hyderabad.
8. Jan Van Sickle, (2008). GPS for Land Surveyors, CRC Press, Taylor & Francis Group, New York.
9. NelSamama, (2008). Global Positioning Techniques and Performance, John Wiley and Sons, Inc., New Jersey.
10. Ganesh, A., (2006). Dimensions of Geomatics, Bharathidasan University, Tiruchirappalli.

Web References:

1. http://www.unoosa.org/pdf/icg/2013/Ed_GNSS_eBook.pdf
2. https://www.ion.org/publications/online-tutorial-intertial.cfm
3. https://www.novatel.com/an-introduction-to-gnss/
4. https://serc.carleton.edu/getsi/teaching_materials/high-precision/unit1.html
5. https://www.e-education.psu.edu/geog862/node/1407

Course Outcomes:

Students will able to:

1. Describe the principles of GNSS based positioning methods, the main components in a satellite navigation system and their functions.
2. Implement basic algorithms for estimation of GNSS based positions
3. Plan, perform and process precise GNSS measurements
4. Formulate the role of GNSS, or GNSS based products and services, in sustainable development.
5. Gain ideas about GPS'S Satellite geometry and GPS coordinate system.
6. Gain practical ideas about Geodetic Surveying and It's Measuring techniques and Pre survey preparations.
7. Knowledge on Total station, GNSS and GIS Integration techniques and also Technology convergence for data use.
8. Understand the hardware and software control systems
9. Acquire ideas on GNSS Applications in Navigation, Tracking, Mapping and Tinning.
10. Differentiate public and secured line services of GPS

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester II	
Course Code / Title	**22CC07 - Digital Photogrammetry**	

Objectives

1. *To acquire knowledge in basic concepts of Photogrammetry and Mapping.*
2. *Generate digital orthophotos from various high-resolution images*
3. *Capture various spatial features through stereo images*
4. *Perform terrain analysis using orthophotos*

Unit 1:	**Digital photogrammetry**: Development of digital photogrammetry – Components: hardware – software, data acquisition: scanners - platforms: Aircrafts – UAV – satellites (CARTOSAT, GEOEYE, WORLDVIEW, Kompsat-3, Pléiades-HR.
Unit 2:	**Stereo image analysis**: interior orientation – exterior orientation – aerial triangulation – Ground Control points, stereo mode: anaglyph – polarization - flicker.
Unit 3:	**Terrain Analysis:** DEM – DSM – DTM – contour extraction and editing – ortho rectification – resampling - mosaic: simple and seamless, 2D and 3D feature extraction.
Unit 4:	**Close range photogrammetry:** Introduction – platforms – image acquisition systems: CCD – Laser – planning and processing – applications
Unit 5:	**Photogrammetric Modelling and Applications:** 3D visualization - large scale mapping – infrastructure mapping – forensic - archaeology and disaster.

Unit 6: Current Contours: Not for Examination Only for Discussion

Photogrammetric Products; Digital Photogrammetric Workstations; Stereo Plotter, Analytical Plotter; Softcopy Workstation; Automatic Object Recognition; Pipeline Ortho fixing

References:

1. Karl Kraus (2007) Photogrammetry – Geometry from Images and Laser Scans, Walter de Gruyter, Berlin.
2. Wilfried Linder (2003) Digital Photogrammetry: Theory and Applications, Springer – Verlag, Berlin Heidelberg.
3. Wolf. P.R., (1974). Elements of Photogrammetry, McGraw Hill books Co., London.
4. Yves Egels, Michel Kasser (2002) Digital Photogrammetry, Taylor & Francis Group, London, UK.
5. Zhilin Li (2008) Advances in Photogrammetry, Remote Sensing and Spatial Information Sciences, CRC Press, Taylor & Francis Group, London, UK.
6. Edward M. Mikhail (2001). Introduction to modern photogrammetry, John Wiley & Sons.
7. Chris McGlone J. (2013). Manual of Photogrammetry, American Society for Photogrammetry and Remote Sensing (ASPRS), USA.
8. Francesco Mancini Riccardo Salvini (2020) Applications of Photogrammetry for Environmental Research, ISPRS, MDPI
9. Rainer Sandau (2010). Digital Airborne Camera: Introduction and Technology, Springer Science & Business Media.
10. Roger E. Read (2002). Manual of Aerial Survey: Primary Data Acquisition, Whittles.

Web References:

1. www.isprs.org
2. www.hexagongeospatial.com
3. www.nrsc.gov.in
4. https://bhuvan.nrsc.gov.in/
5. https://www.e-education.psu.edu/geog862/node/1407

Course Outcomes:

Students will able to:

1. Acquire knowledge on the Development of Digital Photogrammetry, its Software and Hardware components.
2. Understand the concepts of Stereo image analysis includes interior orientation, exterior

orientation and aerial triangulation.
3. Work on DEM, DSM, DTM and Contour Extraction and edition and also Ortho Rectification.
4. Explore the skills on 2D and 3D feature extraction.
5. Obtain knowledge on image acquisition systems, CCD, Laser's planning and processing and its applications.
6. Perform seamless data extraction
7. Know about 3D visualization and large-scale mapping.
8. Understand planning and processing of photogrammetric data
9. Work on Photogrammetric Modelling.
10. Appreciate the Photogrammetric Modelling applications in Infrastructure Mapping, Forensic, Archaeology and Disaster studies.

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester II	
Course Code / Title	**22CC08 - Microwave and Hyperspectral Remote Sensing**	

Objectives

1. *To impart the knowledge of Microwave Remote sensing and its applications.*
2. *To understand principles, processes, and applications of hyper spectral remote sensing for earth resources.*
3. *Obtain knowledge on interferometry and its applications*
4. *Calibrate microwave and hyperspectral data to perform the analysis*

Unit 1:	**Microwave remote sensing:** Introduction to microwave remote sensing - Microwave regions of EM Spectrum – active microwave frequencies (spectrum) – airborne and space born instruments - applications of passive and active micro wave remote sensing
Unit 2:	**Image processing of microwave data:** Imaging and non-imaging instruments - interaction with earth surface - surface scattering - emission, resolution concepts - SLAR – SAR - geometry of radar images - radar return and image signature and characteristics - image processing and interpretation of radar images.
Unit 3:	**Interferometry and polarimetry:** Principles of SAR interferometry: image registration - interferogram generation -phase unwrapping -extraction of elevation and geocoding, polarimetry – principles – types of polarimetry – applications.
Unit 4:	**Hyperspectral Imaging:** Development and Description of Hyperspectral Imaging - Spectral Radiometry – spectral library - Imaging Spectrometers: handheld – aerial – space, Hyperspectral image processing– pre-processing: noise removal atmospheric correction and geometric correction, Image classification: algorithms and feature extraction.
Unit 5:	**Microwave and Hyperspectral applications:** Agricultural, soil, disaster, environmental, forestry and geology (Case studies)

Unit 6: Current Contours: Not for Examination Only for Discussion

Microwave Remote Sensing in search and rescue operations, ground and air target detection and tracking; Hyperspectral Remote Sensing in lithology, mineral exploration and Gap dynamics, environmental and resource management.

References:

1. Lillisand. T.M, and Kiefer, P.W., (1998). Remote Sensing and Image Interpretation, John Wiley & Sons, New York.
2. Ulaby F.T., G. Long (2014) Microwave Radar and Radiometric Remote Sensing, University of Michigan Press, USA.
3. Marcus Borengasser, William S. Hungate, and Russell Watkins (2007) Hyperspectral Remote Sensing Principles and Applications by, CRC Press, London.
4. Floyd M. Henderson and Anthony J. Lewis (2012) Principles and Application of Imaging Radar, Manual of Remote Sensing: Manual of Remote Sensing - Vol. 2, Wiley, India.
5. Ruiliang Pu (2017). Hyperspectral Remote Sensing: Fundamentals and Practices, CRC Press, Boca Raton.
6. Shen-En Qian (2020). Hyperspectral Satellites and System Design, CRC Press, Boca Raton.
7. Prasad S. Thenkabail, John G. Lyon (2016). Hyperspectral Remote Sensing of Vegetation, CRC Press, Boca Raton.
8. Prem Chandra Pandey (2020). Hyperspectral Remote Sensing: Theory and Applications, Elsevier.
9. Chein-I Chang (2007). Hyperspectral Data Exploitation: Theory and Applications, John Wiley & Sons
10. Iain H. Woodhouse (2019). Introduction to Microwave Remote Sensing, CRC Press.

Web References:

1. https://www.nrcan.gc.ca/maps-tools-and-publications/satellite-imagery-and-air-photos/tutorial-fundamentals-remote-sensing/microwave-remote-sensing/9371
2. http://sar.kangwon.ac.kr/etc/rs_note/rsnote/cp3/cp3-1.htm
3. http://www.irea.cnr.it/en/
4. www.rst.gsfc.nasa.gov
5. www.ccrs.nrcan.gc.ca/resource/tutor/fundam/index_e.php

Course Outcomes:

Students will able to:

1. Understand the concepts on microwave remote sensing and its types (active and passive), microwave regions and also airborne and space borne microwave instruments.
2. Discuss the resolutions (azimuth and range), interactions of microwave energy with earth surface, working principles of SLAR and SAR.
3. Handle microwave image processing techniques and RADAR image interpretations.
4. Describe the with interferometry concepts.
5. Appreciate the polarimetry principles, types, and applications.
6. Articulate the topics on hyperspectral remote sensing and hyperspectral image processing, noise removal, atmospheric correction and geometric correction and image classification.
7. Appreciate the microwave remote sensing applications on agriculture, soil, disaster, environmental, forestry and geology.
8. Understand spectral libraries for various satellites
9. Perform pre and post processing of passive satellite images
10. Quantify the hyperspectral remote sensing applications on agriculture, soil, disaster, environmental, forestry and geology.

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester II	
Course Code / Title	**22CC09 - Digital Image Processing**	

Objectives

1. *The objective of the course is to describe about the procedure Digital image processing and analysis.*
2. *To get familiarized about various image enhancement and image processing techniques.*
3. *Perform various image classifications and analysis*
4. *Analyse multi temporal data using image overlay techniques*

Unit 1:	**Introduction to Digital Image Processing:** Remote Sensing Process - Analog to Digital data – Digital image data formats - Image processing system characteristics - Initial statistical extraction: histograms, univariate and multivariate statistics – Scientific visualization - Image Preprocessing: calculating radiance from DNs - atmospheric, radiometric and geometric correction.
Unit 2:	**Image Enhancement:** Contrast enhancement: linear, non-linear and level slicing – Spatial feature enhancement: spatial filtering, edge enhancement and fourier and wavelet transform – multi-image enhancement – band ratioing, principal component analysis, vegetation indices, IHS and texture transformations and image fusion.
Unit 3:	**Image Classification:** Supervised classification: classification algorithm and training site selection - Unsupervised classification – Hybrid classification – Classification of mixed pixels: spectral mixture analysis and fuzzy classification – Post classification smoothing – Ancillary data - Classification accuracy assessment - Artificial Neural Networks - Contextual Classification - Object-Oriented Classification – Machine Learning – ensemble models.
Unit 4:	**Digital Change detection:** LULC system – resolution considerations – environmental characteristics - change detection algorithms –data merging – GIS integration – cartographic modelling.
Unit 5:	**Hyperspectral Image Analysis:** Imaging Spectroscopy - Spectral Libraries - Data Processing techniques: nDimensional, scatter plots, spectral angle mapping, and spectral mixture analysis - Wavelet Analysis for Hyperspectral Imagery.

Unit 6: Current Contours: Not for Examination Only for Discussion

Automatic image enhancement and restoration; Automatic object segmentation; Automatic object detection, classification and recognition; Text recognition and Information extraction; Application of Digital Image Processing in Forensics

References:

1. Jensen, J. R., (2006). Introductory Digital Image Processing: A Remote Sensing Perspective, 3rd Edition, Prentice-Hall Inc., New Jersey.
2. Lillisand, T.M., and Kiefer, P.W., (2007). Remote Sensing and Image Interpretation, 6th Edition, John Wiley & Sons, New York.
3. Campbell, J. B. and Wynne, R.H., (2011). Introduction to Remote Sensing, 5th Edition, The Guilford Press, New York.
4. Gonzalez, R. C. and Woods, R. E., (2007). Digital Image Processing, 3rd Edition, Prentice-Hall Inc. Upper Saddle River, New Jersey.
5. Richards, J. A. and Jia Xiuping (2005). Remote Sensing Digital Image Analysis: An Introduction, 4th Edition, Springer –Verlag, Berlin.
6. Gibson, P. and Power, C. H., (2000). Introductory Remote Sensing: Digital Image Processing and Applications, Routledge Publisher, London.
7. Pierre Soille (2013). Morphological Image Analysis: Principles and Applications, Springer Science & Business Media.
8. Wilhelm Burger (2010). Principles of Digital Image Processing: Core Algorithms, Springer Science & Business Media.
9. Bernd Jähne (2005). Digital Image Processing, Springer Berlin, Heidelberg.
10. Jude Hemant (2020). Artificial Intelligence Techniques for Satellite Image Analysis Remote Sensing

and Digital Image Processing, Springer, India.

Web References:

1. https://uwescience.github.io/sat-image-analysis/resources.html
2. https://agisoft.freshdesk.com/support/solutions/articles/31000153729-satellite-imagery-processing
3. https://www.esa.int/SPECIALS/Eduspace_EN/SEMHA60P0WF_0.html
4. https://engineering.purdue.edu/~bouman/ece637/
5. https://www.iare.ac.in/sites/default/files/lecture_notes/DIP-LECTURE_NOTES.pdf

Course Outcomes:

Students will able to:

1. Understand the Digital data, Data formats and Image processing system.
2. Appreciate the Image Pre-processing, Sources of Radiometric and Geometric distortion and also Atmospheric, Radiometric and Geometric Correction.
3. Discuss on Contrast enhancement that includes Linear and Non-linear Contrast Enhancement and also Histogram Equalization; Density Slicing.
4. Apply Spatial Feature Enhancement, Spatial Filtering and Edge Detection and Enhancement.
5. Quantify the satellite data by using band rationing, vegetation indices, Principal component transformations and tasselled cap transformation.
6. Discuss the application of Fourier transformation, Wavelet transformation, IHS and texture transformations and Image fusion on satellite data.
7. Classify satellite images using classification techniques and carry out accuracy assessment
8. Merge multi satellite images into single data
9. Apply Image classification methods on various satellite images.
10. Apply change detection and accuracy assessment on satellite images.

Programme	M.Tech., Geoinformatics	Credits: 03
	Semester II	
Course Code / Title	**22CC10 - Photogrammetry and Image Processing Lab**	

Objectives

1. *To acquire skill in photogrammetry and Image processing*
2. *Understand the concepts of raster data manipulation*
3. *Perform raster analysis – single and multi-layer analysis*
4. *Analyse multiband and hyperspectral data for resource identification and classification*

Unit 1:	Lab 1: Introduction to Photogrammetry suite and creation of block file. Lab 2: Orthophoto generation from frame camera, digital camera and satellite images Lab 3: Future extraction and DEM generation.
Unit 2:	Lab 4: Remote Sensing Image Display and Initial Statistical Extraction Lab 5: Computing Image Statistics Using ERDAS' IMAGINE Model Maker and ENVI
Unit 3:	Lab 6: Radiometric and Atmospheric Correction Lab 7: Geometric Correction Lab 8: Contrast Manipulation Lab 9: Spatial Feature Manipulation
Unit 4:	Lab 10: Multi-image Manipulation Lab 11: Resolution Merge Lab 12: Spectro Radiometric Survey
Unit 5:	Lab 13: Image Classification Lab 14: Change Detection Lab 15: Hyperspectral Image Analysis

Unit 6: Current Contours: Not for Examination Only for Discussion

SAR Data processing, Machine and Deep learning, Patten recognition, Video data processing

References:

1. Lillisand. T.M., and Kiefer, P.W., (1998). Remote Sensing and Image Interpretation, John Wiley & Sons, New York.
2. Jensen, J. R., (2007). Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition, Prentice-Hall Inc., New Jersey.
3. Imagine (2009). Tour Guide Imagine, Leica Geosystem GIS & Mapping, Atlanta.
4. Paul Gibson, and Clare H. Power, (2000). Introductory Remote Sensing: Digital Processing and Applications, Routledge Publisher, London.
5. Richards, J. A. and Jia Xiuping (2005). Remote Sensing Digital Image Analysis: An Introduction, 4th Edition, Springer –Verlag, Berlin.
6. Gupta. R.P., (2005). Remote Sensing Geology (2nd Edition), Springer India, New Delhi.
7. Jude Hemant (2020). Artificial Intelligence Techniques for Satellite Image Analysis Remote Sensing and Digital Image Processing, Springer, India.
8. Sarkar A. K. (1997) Practical Geography: A Systematic Approach, Oriental Longman, Calcutta.
9. Singh, R.L. and Dutt, P.K. (1979) Elements of Practical Geography, Kalyani Publishers, New Delhi.
10. Michael Law (2021) Getting to Know ArcGIS Pro 2.8 Fourth Edition, ESRI Press, U.S.A

Web References:

1. www.isprs.org
2. https://www.l3harrisgeospatial.com/Software-Technology/ENVI
3. www.hexagongeospatial.com
4. https://bhuvan.nrsc.gov.in/
5. www.nbsslup.icar.gov.in

Course Outcomes:

Students will able to:

1. Create new project blocks in photogrammetry and image processing software.
2. Generate DEM using orthophotos of camera and satellite
3. Calibrate the images for analysis
4. Explore the feature extraction from images
5. Perform various corrections like geometric, contrast, atmospheric etc
6. Apply filters to improve the image classification
7. Perform manual calibration of spectral values
8. Classify images using unsupervised and supervised techniques
9. Perform change detection analysis and accuracy assessment
10. Band calibration of hyperspectral data in ENVI

Programme	M.Tech., Geoinformatics	Credits: 03
	Semester II	
Course Code / Title	22CC11 - GIS Customization Lab	

Objectives

1. *To acquire skill in programming*
2. *Understand the concepts of Object Models and Design Diagrams*
3. *Develop custom applications and tools*
4. *Distribute the maps and custom tools across systems and online*

Unit 1:	Lab 1: Customizing the Interface Lab 2: Working with Model Builder
Unit 2:	Lab 3: Programming in Windows Forms Lab 4: Understanding ArcObjects
Unit 3:	Lab 5: Introduction to ArcObjects Add-In Buttons Lab 6: Customize ArcGIS using Add-In Buttons
Unit 4:	Lab 7: Introduction to ArcObjects Extend Tools Lab 8: Customize ArcGIS using Extend Tools
Unit 5:	Lab 9: Packaging and Installation of Custom Tools Lab 10: Publishing Spatial Data Using GeoServer

Unit 6: Current Contours: Not for Examination Only for Discussion

- Model builder
- Web map publication
- Cloud GIS

References:

1. Michael Law (2021) Getting to Know ArcGIS Pro 2.8 Fourth Edition, ESRI Press, U.S.A
2. Pouria Amirian, (2013) Beginning ArcGIS for Desktop Development using .NET, John Wiley & Sons Ltd, UK.
3. Robert Burke, (2003) Getting to Know Arc Objects: Programming ArcGIS with VBA, ESRI Press, Redlands, USA.
4. ESRI Tutorial, (2009) Introduction to Programming ArcObjects Using the Microsoft .NET Framework, ESRI, Redlands, USA
5. Kang-Tsung Chang., (2006) Programming Arc Objects with VBA: A Task-Oriented Approach, Second Edition Geodatabase Workbook, ESRI Press, Redlands, USA
6. Bill Korpla., (2005) Beginning MapServer Open-Source GIS Development, A Press, New York.
7. Hussein Nasser, (2015). ArcGIS By Example, Packt Publishing Ltd.
8. Hussein Nasser, (2014). Learning ArcGIS Geodatabases, Packt Publishing Ltd.
9. Hussein Nasser, (2014). Building Web Applications with ArcGIS, Packt Publishing Ltd.
10. Michael Zeiler, (2001). Exploring ArcObjects, ESRI Press.

Web References:

1. https://desktop.arcgis.com/en/arcobjects/latest/net/webframe.htm#welcome.htm
2. https://www.e-education.psu.edu/geog489/home.html
3. https://www.e-education.psu.edu/geog485/node/91
4. https://www.e-education.psu.edu/geog863/node/1776
5. https://libguides.utk.edu/gistraining/arcgis

Course Outcomes:
Students will able to:

1. Understand the concepts in customization using programming languages
2. Demonstrate Model builders to automate geoprocessing
3. Develop add-in tools and standalone applications using windows forms
4. Understand the Object Model Diagrams
5. Develop tools using Add-In functions
6. Develop tools using Extending function
7. Distinguish add-in tools and extend tools to develop tools and applications
8. Create software packages and executables to distribute the application
9. Publish results into online web portals that can be accessed through internet
10. Understand the current and future trends in programming for employment

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester II	
Course Code / Title	**22CC12 - Spatial Database Management**	

Objectives

1. *To develop working skill in generation / extraction of spatial & non-spatial database and their analysis using GIS software.*
2. *To acquaint with various data sources (topomaps, satellite image, Soil map, geologic map, etc) and tools (GPS) for information generation / extraction using GIS software.*
3. *Perform queries to retrieve spatial data.*
4. *Acquire knowledge on various data models to store spatial data efficiently*

Unit 1:	**Introduction:** An overview of database management system, Database system Vs file system, Database system concept and architecture, Data Definitions Language, Definition of GIS, DML, Database Structure, Entity Relationship Model – ER model concepts, Notation for ER diagram, Additional Features of the ER Model.
Unit 2:	**Spatial Database Management Systems:** Introduction to spatial database, Data Storage, Database Structure Models, Database Management system, Normalization, Spatial Relationships, Spatial model, and techniques.
Unit 3:	**Query Language:** SQL – Data Definition – Data Manipulation - Basic structure of SQL – Set operations – Aggregate Functions –Simple queries –spatial Vs non-spatial-Nested sub queries – Complex queries – Views – Trigger - example spatial SQL queries – Object relational SQL
Unit 4:	**Data Models and Data Structures -** Introduction-GIS Data Model-Vector Data Structure-Raster Data Structure-Geodatabase and metadata, Geographic Space Modelling-Entity based –Field based modelling-object oriented models-Spatial class.
Unit 5:	**Design and Development:** Spatial Data Base Systema -Exploring Spatial Geometry, Organizing spatial data, Spatial data relationships and functionalities SDBMS – Customization – Big Data and Analytics – Tools.

Unit 6: Current Contours: Not for Examination Only for Discussion

Big data in GIS; GIS and GPS; 3-D referencing system; Oracle; Data integration;

References:

1. Shashi Shekhar, Sanjay Chawla (2003), Spatial Databases a Tour, Prentice Hall.
2. Philippe Rigaux, Michel Scholl, Agnès Voisard (2001). Spatial Databases, Elsevier.
3. Leo S. Hsu and Regina O. Obe (2021). PostGIS in Action, Manning, U.S.A
4. N. Chomsky, (1972). Syntactic Structures, the Hague: Mouton & Co., Printers.
5. Batty M (1994) Using GIS for visual simulation modelling. GIS World.
6. Batty M (1995) Planning support systems and the new logic of computation. Regional Development Dialogue.
7. Batty M, Densham P (1996) Decision support. GIS and urban planning. Sistema Terra.
8. Batty M, Xie Y (1994) urban analysis in a GIS environment: population density modelling using ARC/INFO. In Fotheringham A. S., Rogerson P. A., (eds) Spatial analysis and GIS. London, Taylor and Francis:
9. Martin Werner, Yao-Yi Chiang (2021) Handbook of Big Geospatial Data, Springer, Switzerland
10. Daniel McInerney (2015) Open sources Geo Spatial tools: Application in earth observation by, Earth system data and models, Springer book,

Web References:

1. https://foss4g.org/
2. https://bhuvan.nrsc.gov.in/
3. www.esri.com
4. https://www.qgis.org/en/site/
5. https://libguides.utk.edu/c.php?g=898340&p=6804428

Course Outcomes:
Students will able to:

1. Introduce graduate students to the potentials of modern geographic information technology to strengthen their professional approach to solving real world problems in their specific field of interest.
2. Contribute to the education and training of professionals and to build the capacity of other organizations the fields of earth sciences, natural resources and environment, public works etc
3. Enable the learner in understanding the application of cryptography in network and information security applications.
4. Understand and contribute toward the significant technical and societal challenges created by large location-based data environments, including architecture, security, integrity, management, scalability;
5. Spatial data can be acquired and used to support various forms of analysis, modelling and geo-visualization in large data environments
6. Develop seamless queries to fetch data intermittently
7. Integrate queries into code view as functions and handle exceptions
8. Demonstrate how artificial intelligence, machine learning, and data mining can be used to augment the typical geographic information science (GIS) concepts and workflows to intelligently mine data to provide enterprise-centric solutions for a variety of societal challenges and issues spanning the public, private and not-for-profit sectors.
9. Determine the overall field of data science, the role of the analyst and/or data scientist, and the domains where spatial data science skills can be applied to critical organization missions.
10. To provide a firm understanding of the conceptual and technical issues that affects the use of GIS and GPS

Course Code / Title	JavaScript Programming	

Course Objectives:

1. *To provide exposure to students in gaining knowledge on concepts and applications*
2. *Develop skill in web application development*
3. *Write applications with high performance with integrated security*

Unit 1:	Syntax, Variables, Values, Data Types - Data Types - Expressions and Operators - Control structures
Unit 2:	Error handling - Numbers – Strings – Arrays
Unit 3:	Functions - Indexed Collections – JSON - JIterators and generators
Unit 4:	Modules - Regular Expressions – Objects - Prototype based Object Oriented Programming - Classes
Unit 5:	General overview of server-side JavaScript - JavaScript in Web browser - Browser Object Model - Document Object Model - Handling Events – AJAX - Data Storage

Unit 6: Current Contours: Not for Examination Only for Discussion

JavaScript in GIS, API, REST, SOAP, GIS Services

References:

1. A Smarter Way to Learn JavaScript, Mark Myers, 1st edition, Lightning Source Inc
2. JavaScript: The Definitive Guide, David Flanagan, 1st edition, O'Reilly Media
3. Head First JavaScript Programming, Eric T Morrison, 1st edition, O'Reilly
4. Eloquent JavaScript, 3rd Edition, Marijn Haverbeke, 3rd edition, No Starch Press
5. The Principles of Object-Oriented JavaScript, Nicholas C. Zakas, 1st edition, No Starch Press
6. JavaScript: The Good Parts, Douglas Crockford, O'Reilly Media, Inc.
7. Understanding ECMAScript 6, Nicholas C. Zakas, No Starch Press
8. You Don't Know JS: Scope & Closures, Kyle Simpson, O'Reilly Media
9. Bootstrap Responsive Web Development, Jake Spurlock, O'Reilly Media
10. Learning JavaScript Design Patterns, Addy Osmani, O'Reilly Media

Web References:

1. https://learnjavascript.online/
2. https://www.w3schools.com/js/
3. https://www.javascript.com/resources
4. https://ocw.mit.edu/courses/6-170-software-studio-spring-2013/pages/lecture-notes/
5. https://ocw.mit.edu/

Course Outcomes:

Students will be sable to:

1. Familiar with JavaScript syntax
2. Write coding to analysis spatial data
3. Understand the conceptual design of object-oriented programming
4. Appreciate the graphical programing feasibility in java
5. Comprehended the Swing Components in Java
6. Using visibility modifiers (public, private, protected) to implement appropriate abstraction and encapsulation.
7. Describe the multi thread programming
8. Confident in applying JavaScript in GIS environment
9. Integrate java script in web mapping
10. Apply in the open-source engine to process data

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester III	
Course Code / Title	**22CC13 - Watershed Studies**	

Objectives

1. *This subject deals with the basics concept of watershed and also various remote sensing and GIS applications in the field of hydrology and water resources*
2. *To understand the assessment of Basin and its hydrology using Geospatial technology*
3. *To get exposure to the Groundwater and Watershed Management aspects of GIS*
4. *Students acquire knowledge on Integrated Watershed Development Plan*

Unit 1:	**Concept of Watershed**- Watershed, Hierarchy, delineation-traditional to modern - Indian watershed atlas - watershed management in India, River Valley Project (RVP) - Hill Area Development Programme (HADP) - National Watershed Development Programme for Rainfed Agriculture (NWDPRA).
Unit 2:	**Watershed Characteristics**: Drainage Morphometry: areal-linear-relief-hydrograph analysis-runoff modelling-surface water modelling-Data Generation-Digital Elevation Model-soil data- landuse/land cover-climate data-surface water system model-HEC-RAS – HEC HMS.
Unit 3:	**Groundwater:** Groundwater origin and occurrence-storage-types of aquifers-groundwater movement-quantity-quality-level- suitability for drinking and irrigation -Groundwater Modelling- Ground water recharge – percolation ponds - Water harvesting - Farm pond - Supplemental irrigation - Groundwater potential zone mapping-vulnerability-recharge-MODFLOW-DRASTIC.
Unit 4:	**Watershed and Land use planning**- Physical land capability, irrigability and suitability – watershed and land use planning Database – Thematic layers-Weightage, Ranking and Rating Scale-Integration-Suitability Classification-Crop suitability (Rice, Banana, Groundnut and Cotton) - Environmental and socio-economic perspective on Integrated watershed management.
Unit 5:	**Recent Geoinformatics Approaches in Watershed studies:** Soil erosion model RUSLE-WEPP-Watershed prioritization-SWAT-GIS for Water supply and irrigation-GIS decision support system for flood management-reservoir siltation-inner basin water transfer, Application of Geoinformatics in Integrated Watershed Development Plan.

Unit 6: Current Contours: Not for Examination Only for Discussion

Sustainability; Interstate Water disputes; Integrated watershed management; Participatory rural appraisal in watershed management; New conservation approaches

References:

1. Todd, D.K (1989) Groundwater Hydrology, John Wiley Sons, New Delhi
2. Lyon, J.G (2003) GIS for Water Resources and Watershed Management. Taylor and Francis, New York.
3. Sharad K. Jain, V.P Singh (2003) Water Resources Systems Planning and Management, Elsevier B.V, Netherlands.
4. David R Maidment (2002) Arc Hydro: GIS for Water Resources, Volume ESRI Press, Redlands, USA.
5. Lynn E Johnson (2009) Geographic Information systems in water resources engineering, Taylor and Francis Group, New York.
6. Chow, David R Maidment, Larry W. Mays (2010) Applied Hydrology, McGraw Hill Book Company, New Delhi.
7. Murthy, V.V.N. and M.K. Jha (2015) Land and Water Management, Kalyani Publishers, New Delhi
8. Morgan R.P. (2009). Soil Erosion and Conservation, John Wiley and Sons, Inida
9. Prem C. Pandey (Editor), Laxmi K. Sharma (2021) Advances in Remote Sensing for Natural Resource Monitoring, Wiley-Blackwell, India
10. Brian D. Fath, Sven Erik Jorgensen (2020) Managing Water Resources and Hydrological Systems, CRC Press, U.S.A

Web References:

1. http://www.ce.utexas.edu/prof/maidment/visual/dallas/jay/sld001.htm
2. http://resources.arcgis.com/en/communities/hydro/
3. http://cgwb.gov.in/
4. https://indiawris.gov.in/wris/
5. https://www.fao.org/3/x5310e/x5310e00.htm

Course Outcomes:

Students will able to:

1. Understand the concepts of watershed and Indian Hierarchal classification and coding.
2. Discuss the various watershed programme implemented in India.
3. Familiar with Drainage morphometry and its controlling factors.
4. Measure evaporation and evapotranspiration and relationship between actual and potential evapotranspiration
5. Understand Infiltration, origin and occurrence of groundwater, aquifers, groundwater quality and Mapping methods etc
6. Approaches to planning and development of water resources and methods to evaluate surface water resources and groundwater, policies and management.
7. Evaluate land for suitability of agricultural products
8. Integrate mathematical models into GIS systems to perform analysis
9. Use of GIS for surface water modelling, groundwater modelling, and flood plain mapping.
10. Apply GIS in water quality monitoring, water resource planning and management and Hydrologic Information System

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester III	
Course Code / Title	**22CC14 - Disaster Studies**	

Objectives

1. *To understand the fundamentals and measurements of disaster management*
2. *To gain exposure to various space-based input for disaster management*
3. *To understand the use of spatial data for emergency planning*
4. *To teach about the various principles involved and also the various mitigation to be adopted during the disasters.*

Unit 1:	**Disasters and GIS:** Meaning and types of hazards, disasters and catastrophes – Disaster Management; Earthquakes: causes and effects – measurements - earthquake zones of the world and India – vulnerability and microzonation; Volcanoes: Causes and effects – volcanic zones of the world and in India - volcanic hazards; Landslides: Causes and effects – landslide prone zones in India – GIS case studies for earthquake, volcano and landslide.
Unit 2:	**Cyclones and Flooding:** Cyclone: Origin and types - effects on land and sea – damage assessment; Flooding: Topography, land use and flooding – Space-time integration – GIS based parameters and layers – flood prone area analysis and management – risk assessment – GIS case studies for cyclones and floods.
Unit 3:	**Drought and Desertification:** Drought: Types – factors influencing drought – variable identification – vegetation index – land use / ground water level changes – soil erosion – delimiting drought prone areas – short term and long-term effects – Desertification: Processes – over utilization of water and land resources – GIS based management strategies – GIS case studies for drought and desertification.
Unit 4:	**Anthropogenic Disasters:** Atmospheric Disasters: Ozone layer depletion – green house / global warming – acid rain – snow melt – sea level rise – related problems; Nuclear, Chemical / Industrial and Mining Disasters: Types – consequences – major disasters of the world and India; Marine Disasters: Oil spill and chemical pollution – coastal erosion and deposition – coastal zone management strategies – GIS case studies for anthropogenic disasters.
Unit 5:	**Biological Disasters and Disaster Management Issues:** Diseases and human health: Epidemics – disease spread – GIS analysis; Ecological degradation – bio-diversity loss – population extinction – conservation; Biodiversity Gap Analysis; Coral / mangrove depletion – forest fire impacts – overlay analysis – GIS in environmental modelling – GIS case studies; Disaster Management: United Nations, Central and State Governments of India in Disaster Management - Institutional and Policy Framework - Disaster Prevention and Mitigation –Preparedness.

Unit 6: Current Contours: Not for Examination Only for Discussion

Long history of standardized data compilation, validation and analysis; Rational decision-making in disaster situations; Providing information on the human impact of disasters; Creating awareness in disaster preparedness

References:

1. National Disaster Management Division (2004) Disaster Management in India - A Status Report, Ministry of Home Affairs, Government of India, New Delhi.
2. Matthews, J.A., (2002) Natural Hazards and Environmental Change, Bill McGuire, Ian Mason.
3. Skeil, A (2002) Environmental Modelling with GIS and Remote sensing, John Wiley and sons, New York.
4. Singh, R.B (Ed.) (1996) Disasters, Environment and Development, Oxford & IBH, New Delhi.
5. Barrett E.C., and L. F. Curtis, (1992) Introduction to Environmental Remote Sensing, Chapman and Hall, London.
6. UNDRO (1995) Guidelines for Hazard Evaluation Procedures, United Nations Disasters Relief Organization, Vienna.

7. Nagarajan, R., (2004) Landslide Disaster Assessment and Monitoring, Anmol Publications, New Delhi.
8. Brian D. Fath, Sven Erik Jorgensen (2020) Managing Water Resources and Hydrological Systems, CRC Press, U.S.A
9. Ramkumar, Mu, (2009) Geological Hazards: Causes, Consequences and Methods of Containment, New India Publishing Agency, New Delhi.
10. Brian Tomaszewski (2020) Geographic Information Systems (GIS) for Disaster Management, Routledge, U.K.

Web References:

1. www. nidm.gov.in
2. https://tnsdma.tn.gov.in
3. https://www.undrr.org/
4. http://resources.arcgis.com/en/communities/
5. https://indiawris.gov.in/wris/

Course Outcomes:

Students will able to:

1. Acquire knowledge about hazards, disasters and catastrophes and also Disaster Management
2. Discover the causes and effects of Earthquakes, Volcanic hazards, Landslide with GIS case studies
3. Acquire knowledge on Origin, types, effects and damage assessment of Cyclones and Flooding
4. Learn about preparation of GIS based parameters and layers for analysis
5. Demonstrate the causes and effects of Drought and Desertification, GIS based management strategies and also GIS case studies for drought and desertification.
6. Understand Atmospheric Disasters like Ozone layer depletion, green house, global warming, acid rain, snow melt, and sea level rise with GIS case studies
7. Demonstrate skill in Nuclear, Chemical / Industrial and Mining Disasters and Marine Disasters like Oil spill and chemical pollution, coastal erosion and deposition with GIS based coastal zone management strategies
8. Discuss the Biological Disasters like Epidemics, Ecological degradation, bio-diversity loss, population extinction, Coral / mangrove depletion, forest fire with GIS case studies
9. Perform case studies for pre and post disaster situations
10. Help government agencies to form necessary action plans and strategies to mitigate disaster

Programme	M.Tech., Geoinformatics	Credits: 04
	Semester III	
Course Code / Title	**22CC15 - Urban Studies**	

Objectives

1. *To introduce the concepts of urban and to explore the use of the geospatial technology in advanced analysis in planning.*
2. *To gain knowledge of urban and regional planning concepts, the use of geomatics technology in planning and management in urban areas.*
3. *To introduce Geoinformatics to students in urban studies*
4. *To get exposure in modelling in urban land use and it's forecasting.*

Unit 1:	**Basic Concepts:** Urban - urban morphology – Urban hierarchy - urbanization in India and World – Problems of Urbanization-urban indicators and monitoring – urban information system.
Unit 2:	**Urban Database**: Platforms - scale and resolution – scope and limitations – interpretation from aerial and satellite images – GNNS survey for data collection-BHUVAN Thematic map service –cadastral data – mobile mapping - Lidar, digital image processing technique; image classification – image fusion - feature extraction - Hyperspectral Remote Sensing – Radar Remote Sensing-Drone Survey.
Unit 3:	**Urban Dynamics** – Land use & Land Cover Classification (NRSC)- Urban Expansion-Sprawl and Density - Physical Patterns and Forms - Causes and Consequences - Monitoring Urban Growth analysis through Remote Sensing - Urban infrastructure - utility mapping – change analysis – 2D and 3D mapping- CBD– fringe dynamics.
Unit 4:	**Urban Administration**: Slums and Municipal administration – water supply and Water Demand Analysis– solid waste management and sanitation -– recreation site identification – network analysis – optimum route/ shortest route –traffic and parking studies – accident analysis – vehicle tracking - case studies.
Unit 5:	**Geoinformatics for Urban Management:** Community based planning – social service delivery - Urban Environmental Monitoring and Modelling – healthcare services - homeland Security – Urban Hazard & Risk Assessment – archaeology - location based services (LBS) – Virtual 3D city modelling and applications.

Unit 6: Current Contours: Not for Examination Only for Discussion

Use of CAD for urban planning; Case studies on urban growth prediction and healthcare services; Case studies on Urban Environment Quality (UEQ) assessment; Case studies on Virtual 3D city modelling; Google Earth Engine for Urban Planning

References:

1. Jean-Paul Donnay, Mike J Barnsley and Paul A Longley., (2001) Remote Sensing and Urban Analysis, Taylor and Francis, London.
2. Harold Carter., (1995) the Study of Urban Geography, Arnold, A Division of Hodder Headline, PLC, London.
3. Poonam Sharma (2021) Geospatial Technology and Smart Cities, Springer, Switzerland
4. William E Huxhold., (1991) an Introduction to Urban Geographic Information Systems. Oxford University Press.
5. Timothy.L.N and Piotr Jankowski(2010) Regional and Urban GIS A Decision Support Approach, The Guilford press, New York.
6. Julina and John Ziegler (2006) GIS for the Urban Environment, ESRI Press, Redlands, USA.
7. Cory Fleming Ed. (2005) the GIS Guide for Local Government Officials, ESRI Press, Redlands, USA.
8. Ayse Pamuk (2006) Mapping Global Cities, GIS Methods in Urban Analysis, ESRI Press, Redlands, USA.
9. Sameer Sharma (2020) A Textbook of Urban Planning and Geography, PHI Learning Pvt. Ltd, Rimjhim House, 111, Patparganj Industrial Estate, Delhi - 110 092, India.
10. Andrew, E.G.J, McCann, E and Thomas, M (2015). Urban Geography: A Critical Introduction, Wiley, Blackwell, UK.

Web References:

1. http://www.iisd.org/pdf/2006/tas_natres_disasters.pdf
2. http://www.fao.org/docrep/t0715e/t0715e00.HTM
3. http://www.iisd.org/pdf/2006/tas_natres_disasters.pdf
4. http://www.ignouhelp.in/ignou-pgdupdl-study-material/
5. https://mitocw.ups.edu.ec/courses/urban-studies-and-planning/

Course Outcomes:

Students will able to:

1. describe Urban, urban morphology, Urban hierarchy, Urbanization processes and conceptual modelling of urban processes.
2. Understand the urban indicators of urban information system.
3. Appreciate the platforms, scale and resolution, scope and limitations for urban feature extraction.
4. Handle the different types of data collection for urban environ: GPS survey, mapping, Lidar and Digital image processing technique.
5. Prepare thematic layers of various uses for better management of urban
6. Generate data from various platforms
7. Apply the geospatial technology in utility mapping, change analysis, CBD, fringe dynamics, slums and urban sprawl.
8. Apply the geoinformatics techniques on solid waste management, water supply and sanitation, recreation site identification and network analysis.
9. Quantify the optimum route/ shortest route, traffic and parking studies, accident analysis, vehicle tracking and also case studies.
10. Discuss the advanced application like Community based planning, social service delivery, Environmental quality, healthcare services, homeland Security, Emergency management and disaster response, location-based services (LBS), and Virtual 3D city modelling and applications.

Programme	M.Tech., Geoinformatics	Credits: 03
	Semester III	
Course Code / Title	**22CC16 - Resources Evaluation Lab**	

Objectives

1. *To acquire skill in working with various kinds of spatial data*
2. *Understand the concepts of Spatial data models, analysis tools and techniques*
3. *Integrate multiple data layers and to produce accurate results*
4. *Create and utilize models to address and provide GIS based solutions to problems*

Unit 1:	Lab 1: Data Collection for Resources analysis Lab 2: Landuse/Landcover change analysis Lab 3: Crop suitability for rainfed agriculture
Unit 2:	Lab 4: Morphometric analysis Lab 5: Rainfall runoff modelling Lab 6: Soil erosion modelling
Unit 3:	Lab 7: Groundwater prospects zonation Lab 8: Water quality modelling Lab 9: Prioritization of watershed
Unit 4:	Lab 10: Earthquake hazard zonation Lab 11: Landslide susceptibility mapping Lab 12: Strom surge vulnerability assessment
Unit 5:	Lab 13: Flood inundation mapping Lab 14: Drought monitoring and assessment Lab 15: Urban heat island modelling

Unit 6: Current Contours: Not for Examination Only for Discussion

Multi Criteria Analysis, Machine Learning ensemble Model, Web mapping , Cloud GIS

References:

1. Lyon, J.G, (2003) GIS for Water Resource and Watershed Management, Taylor and Francis, New York.
2. Haywood. L, Comelius. S and S. Carver (1988). An Introduction to Geographical Information Systems, Addison Wiley Longmont, New York.
3. Lillisand T.M and R.W. Kiefer (1994). Remote Sensing and Image Interpretation (3rd edition). John Wiley & Sons, New York.
4. Sabins F.F Jr. (1987). Remote Sensing: Principles and Interpretation, W.H.Freeman & Co., New York.
5. Burrough P.A (1986) Principles of Geographical Information System for Land Resources Assessment, Clarendon Press, Oxford.
6. Burrough P A and McDonnell [2000] Principles of Geographical Information Systems, Oxford University Press, London.
7. Lo.C.P., Yeung. K.W. Albert (2002) Concepts and Techniques of Geographic Information Systems, Prentice-Hall of India, New Delhi.
8. Monkhouse, F.J. and Wilkinson, H.R. (1994) Maps and Diagrams, Methuen, London.
9. Sarkar A. K. (1997) Practical Geography: A Systematic Approach, Oriental Longman, Calcutta.
10. Michael Law (2021) Getting to Know ArcGIS Pro 2.8 Fourth Edition, ESRI Press, U.S.A

Web References:

1. www.esri.com
2. www.nrsc.gov.in
3. www.bhuvan.nrsc.gov.in
4. www.arcgis.com
5. www.nbsslup.icar.gov.in

Course Outcomes:
Students will able to:

1. Acquire knowledge in spatial data collection and manipulation
2. Integrate multiple layers and assign weightages according to attributes
3. Perform layer based analysis to derive accurate results
4. Perform land use and land cover analysis based on temporal spatial data
5. Carry out morphometric analysis to quantify the streams and river characteristics
6. Assess rainfall runoff and analyse soil erosion
7. Perform various studies related to ground water for its sustainable recharge
8. Prioritize watersheds based on various problems and support the sustainable development
9. Assess flood and its possible impact on natural and man-made resources
10. Study the impacts of climate change on various systems.

Programme	M.Tech., Geoinformatics	Credits: 03
	Semester III	
Course Code / Title	22CC17 - Mini Project & Viva Voce	

Programme	M.Tech., Geoinformatics	Credits: 03
	Semester III	
Course Code / Title	**22CC18 - Research Ethics, Project Management and IPR**	

Objectives

1. *To understand some basic concepts of research and its methodologies*
2. *To develop understanding of the basic framework of research process and ethics*
3. *Acquire knowledge in project management concepts and tools*
4. *knowledge regarding the principles of IPR, Concept and Theories, Criticisms of Intellectual Property Rights*

Unit 1:	**Philosophy and Ethics:** Introduction - definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgements and reactions - Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data
Unit 2:	**Publication ethics:** definition, introduction and importance, best practices / standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types, Violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals
Unit 3:	**Open Access Publishing:** Open access publications and initiatives, SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.
Unit 4:	**Project Management:** What is Project-Project Attributes-Project Management Knowledge Area-Project Management Tools and Techniques-Project Success Factors-Geoinformatics Projects - GIS Projects Integration-Scope and Time management - Work Breakdown Structure - PERT and CPM: Introduction-Development of Project Network-Time Estimation-Determination of the Critical Path-PERT Model-Measures of Variability-CPM Model-Responsibility and Team Work
Unit 5:	**Intellectual Property Rights (IPR):** Introduction to IPR – Concept, Theories, Types of IPR - Need for Private Rights versus Public Interests - Competition Policy - IPRs and IPRs Policy - Infringement - Advantages and Disadvantages of IPR - TRIPS and other Treaties (WIPO,WTO, GATTS) -

Unit 6: Current Contours: Not for Examination Only for Discussion

- Open Access Publication
- Pattern Publication
- Geo tags
- Startup opportunities

References:

1. Basil Gomez, John Paul Jones., (2010). Research Methods in Geography: A Critical Introduction, John Wiley & Sons, New York.
2. Daniel Montello, Paul Sutton, (2006). An Introduction to Scientific Research Methods in Geography, SAGE.
3. Ron Iphofen (2018). The SAGE Handbook of Qualitative Research Ethics, SAGE.
4. Paige Baltzan (2016). Business Driven Information Systems, McGraw Hill Education, New York.
5. Thomas H. Davenport (2013). Enterprise analytics: optimize performance, process, and decisions through big data, FT Press, New Jersey.
6. David L. Olson (2015). Information Systems Project Management, Business Expert Press, New York.
7. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property (2009), Eastern Book Company, Lucknow

Web References:

1. https://foss4g.org/
2. http://sdeuoc.ac.in/sites/default/files/sde_videos/190459.pdf
3. https://ccsuniversity.ac.in/bridge-library/pdf/Research-Methodology-CR-Kothari.pdf
4. http://www.wbnsou.ac.in/online_services/SLM/PG/MLIS-07.pdf
5. https://mrcet.com/downloads/digital_notes/CSE/Mtech/I%20Year/RESEARCH%20METHODLOGY.pdf

Course Outcomes:

Students will able to:

1. Demonstrate scientific research adhering the ethics of research.
2. Understand various approaches to geographical research.
3. Formulate hypotheses, concepts and facts, principles, law, theory and their implications in geographical research.
4. Competent to produce valuable research
5. Apply and critically evaluate the project management techniques and decision tools within constrained, ambiguous and uncertain business environments
6. Examine, analyse and synthesize the concepts, principles, processes and practice of project management
7. Distinguish various types of laws pertaining to property rights
8. Value and respect the rights and laws by adhering to them

Course Code / Title	VAC-II GIS-Supply Chain Visualization & Analysis	

Course Objectives:

1. *To provide exposure to students in new emerging analytical tools on concepts and Supply Chain data creation.*
2. *Lead to modeling the Supply Chain Visualization & Analysis using GIS*
3. *Visualize spatial dependencies in graph*

Unit 1:	**Data Base Creation:** Multiple Tiers Suppliers –Plants – Products – Managers – Customers - Non-Spatial And Unstructured Data With Spatial And Structured Data
Unit 2:	**Explore the relationships:** Geospatial Context Produces - Supplies - Purchases
Unit 3:	**Visualize and Explore:** Capture Dependencies – origin and destination links
Unit 4:	**Graph Analytics :** Path ways – centrality – Spatial Query
Unit 5:	**Case Study Discussion:** Food Delivery **–** Public distribution System

Unit 6: Current Contours: Not for Examination Only for Discussion

- Crowd source data
- Social media inputs
- Twitter feeds

References:

1. Kurt Y. Liu (2014) Supply Chain Analytics: Concepts, Techniques and Applications, Palgrave Macmillan Cham, license to Springer Nature Switzerland AG 2022.
2. John Wang (2014). Encyclopedia of Business Analytics and Optimization, IGI Global.
3. Nada R. Sanders (2014). Big Data Driven Supply Chain Management A Framework for Implementing Analytics and Turning Information Into Intelligence, Pearson Education.
4. Sunil Chopra, Peter Meindl (2010). Supply Chain Management: Strategy, Planning, and Operation, Pearson.
5. Evelin Krmac (2016). Sustainable Supply Chain Management. IntechOpen.
6. Bhimasankaram Pochiraju, Sridhar Seshadri (2019). Essentials of Business Analytics: An Introduction to the Methodology and Its Applications. (2019). Germany: Springer International Publishing.
7. Liu, K. Y. (2022). Supply Chain Analytics: Concepts, Techniques and Applications. Switzerland: Springer International Publishing.
8. Carter, K. B., Farmer, D. (2014). Actionable Intelligence: A Guide to Delivering Business Results with Big Data Fast!. United Kingdom: Wiley.
9. Drake, M. (2013). The Applied Business Analytics Casebook: Applications in Supply Chain Management, Operations Management, and Operations Research. United Kingdom: Pearson Education.
10. Smith, T. (2013). HR Analytics: The What, Why and How.... United States: Createspace Independent Pub.

Web references:

1. https://www.esri.com/en-us/industries/needs/supply-chain-digitization
2. https://www.esri.com/en-us/industries/retail/strategies/supply-chain-logistics
3. https://www.esri.com/arcgis-blog/products/arcgis-knowledge/analytics/arcgis-knowledge-supply-chain-visualization-analysis/

Course Outcomes:
Students will able to:

1. Understand production and supply systems
2. Understand various geographical approaches to supply chain systems.
3. Formulate hypotheses, concepts and facts, principles, law, theory and their implications in geographical research.
4. Competent to produce valuable research
5. Understand origin and destination links of various prodcuts
6. Examine the processes and practice of supply chain management
7. Distinguish various types of laws pertaining to delivery network
8. Value and respect the rights and laws by adhering to them

Programme	M.Tech., Geoinformatics	Credits: 03
Course Code / Title	Statistics for Data Science	

Objectives

1. *Understand the purpose, meaning, and use of statistics in geographical studies.*
2. *Distinguish data and appropriate statistical analysis to perform*
3. *Apply statistical techniques to real geographical problems*
4. *Take decisions on the basis of statistical inferences*

Unit 1:	**Introduction**: Statistical Methods for Geography - Scientific method and mathematical notation - Descriptive Statistics - Measures of central tendency: Mean, Median, and Mode - Measures of Dispersion: Range, Variance, Standard Deviation, z-score, Skewness, Kurtosis and Histograms.
Unit 2:	**Probability**: Probability Concepts - Discrete Probability Distributions: Uniform, Binomial and Poisson Distributions - Continuous Probability Distributions - Probability Models - Central Limit Theorem and Confidence Intervals
Unit 3:	**Hypothesis Testing and Sampling:** Sources of Data - Sampling - Hypothesis Testing: z-test and t-test - Analysis of Variance (ANOVA).
Unit 4:	**Correlation and Regression:** Covariance - Pearson's Correlation Coefficient - Spearman's Rank Correlation Coefficient – Correlation and Geographic Problems - Regression Analysis.
Unit 5:	**Spatial Patterns:** Data Reduction: Factor Analysis and Cluster Analysis

Unit 6: Current Contours: Not for Examination Only for Discussion

SPSS; R-Language; MATLAB; Stata; Minitab Software; Predictive Modelling

References:

1. Rogerson, P. A. (2001) Statistical Methods for Geography, Sage Publications, New Delhi.
2. Pal, S. K. (1998) Statistics for Geoscientists, Tata McGraw Hill, New Delhi.
3. Hammond, P. and McCullagh, P. S., (1978) Quantitative Techniques in Geography: An Introduction, Oxford University Press, New York.
4. Gareth James (2013). An Introduction to Statistical Learning: with Applications in R, Springer Science & Business Media.
5. Dennis D. Boos (2013). Essential Statistical Inference: Theory and Methods, Springer Science & Business Media.
6. Andy Field (2013) Discovering Statistics Using IBM SPSS Statistics, 4th Edition, Sage Publications, London.
7. George A. Morgan (2011). IBM SPSS for Introductory Statistics, Taylor & Francis.
8. Ajai, S. G. and Sanjaya, S.G. (2009) Statistical Methods for Practice and Research, Sage Publications, New Delhi.
9. Lyman Ott (2015). An Introduction to Statistical Methods and Data Analysis, Cengage Learning.
10. Ding-Geng (Din) Chen, Karl E. Peace (2021) Applied Meta-Analysis with R and Stata.

Web References:

1. https://machinelearningmastery.com/
2. https://www.hackerrank.com/domains/ai/machine-learning
3. https://newonlinecourses.science.psu.edu/stat857/node
4. http://www.unc.edu/courses/2006spring/geog/090/001

Course Outcomes:

Students will able to:

1. Students will frame problems using multiple mathematical and statistical representations of relevant structures and relationships and solve using standard techniques.
2. Demonstrate knowledge of the properties of parametric, semi-parametric and nonparametric testing procedures
3. Interpreting and communicating the results of a statistical analysis
4. Probability and the mathematical foundations of statistics
5. Recognize the importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines

6. Be familiar with a variety of examples where mathematics or statistics helps accurately explain abstract or physical phenomena;
7. Ability to write reports of the results of statistical analyses giving summaries and conclusions using nontechnical language.
8. Provide a description of the method used for analysis, including a discussion of advantages, disadvantages and necessary assumptions.
9. Understand spatial and temporal patterns of data
10. Perform factor and cluster analysis and interpret the results

Programme	M.Tech., Geoinformatics	Credits: 03
Course Code / Title	C++ Programming	

Objectives

1. *To learn the fundamental programming concepts and methodologies which are essential to building good C/C++ programs.*
2. *Understand the data types, keywords and language frameworks*
3. *Develop logical thinking abilities*
4. *Perform basic programming fundamentals through laboratory works*

Unit 1:	**Object Oriented Program in C++:** Principles, characteristics, benefits and applications; structure of C++ programme, simple C++ programme and example with class.
Unit 2:	**Keywords and Statements:** Token keywords - data type - variable and array - operator - control statements, if - else, else if, nested if, while, do - while, go - to jump continue, for - loop, switch statement.
Unit 3:	**Functions:** function in C++ - types of function - inline function - recursive function - arrays - Polymorphism - compile time polymorphism - run time polymorphism - function overloading - operator overloading - function overriding - virtual function.
Unit 4:	**OOP:** Inheritance - single inheritance - multiple inheritance - multilevel inheritance - hierarchical inheritance - hybrid inheritance
Unit 5:	**Working with Files:** Classes for file stream operations - opening and closing file - sequential input and output operations - updating a file: Random Access - Error handling during file operations

Unit 6: Current Contours: Not for Examination Only for Discussion

Marquee Behavior from (left to right, top to bottom); How application linked with Scripting (eg Facebook, Google search); Computer Graphics code; Geo server; Mobile developments;

References:

1. Ira Pohl (2003). Object–Oriented Programming Using C++, Pearson Education, New Delhi.
2. Bjarne Stroustrup (2004). The C++ Programming Language, Pearson Education, New Delhi.
3. Bjarne Stroustrup (2014). Programming Principles and Practice Using C++, Pearson Education.
4. Stanley B. Lippman and Josee Lajoie (2003). C++ Primer, Pearson Education, New Delhi.
5. Venugopal, K. R., Rajkumar Buyya, and Ravishankar, T. (2003). Mastering C++, TMH, New Delhi.
6. Balagurusamy E. (2008). C++ Programming, Tata McGraw–Hill Education.
7. Scott Meyers (2014). Effective Modern C++, O'Reilly Media.
8. Andrew Koenig (2000). Accelerated C++: Practical Programming by Example, Addison-Wesley.
9. Alexandrescu (2001). Modern C++ Design: Generic Programming and Design Patterns Applied, Pearson Education.
10. Marc Gregoire, (2021). Professional C++, Wiley, U.S.A

Web References:

1. https://www.w3schools.com/cpp/cpp_intro.asp
2. https://www.programiz.com/cpp-programming
3. https://cplusplus.com/doc/tutorial/
4. https://www. Softwaretestinghelp.com/cpp-programing
5. https://www. Cprograming.com/tutorial/c++tutoriaol.html

Course Outcomes:

Students will able to:

1. Generate an application based upon the concepts of C++ & Object-oriented Programming
2. Create and communicate between client and server using Java and create a good, effective and dynamic website
3. Understand, analyse and apply the role languages like HTML, CSS, XML, JavaScript and protocols in the workings of web and web applications

4. To implement the object-oriented modelling and design patterns to provide solutions to the real-world software design problems.
5. Use Unix commands to manage files and develop programs, including multi-module programs
6. Demonstrate adeptness of object-oriented programming in developing solutions to problems demonstrating usage of data abstraction, encapsulation, and inheritance.
7. Perform object-oriented programming to develop solutions to problems demonstrating usage of control structures, modularity, I/O. and other standard language constructs.
8. Apply the concepts and principles of the programming language to the real-world problems and solve the problems through project-based learning
9. Working principle of file system for create, update and delete
10. Fix compile time and run time errors efficiently

Course Code / Title	Spatial Analysis	Credits: 03

Course Objectives:

1. *To provide an overview of an introduction to the range of statistical techniques used in the analysis of spatial (geographic) data.*
2. *To prepare, manipulate, display and analyse spatial data.*
3. *To synthesise and present high-quality GIS-based outputs in research report*

Unit 1:	**Concept of spatial organization:** Physical and relative space - Spatial structure and arrangements – Location and distance: – Straight line – Shortest path – Manhattan (Rectilinear) - Location: Single and multiple locations and regions - Spatial organization: Differentiation – Process – Interaction between places and regions.
Unit 2:	**Analysis of point entity:** Distribution and density: Centrography – Near neighbourhood and reflexive neighbour - Mapping density analysis (Isometry, Desymetry) – Point buffers.
Unit 3:	**Analysis of line entity:** Network topology – Connectivity analysis: Shortest path and total connectivity (one edge to n (diameter) edges - Detour index and allocation assignment- Accessibility - Buffers.
Unit 4:	**Analysis of area entity / surface:** Index of concentration and diversification – Interpolation techniques – Trend surface analysis (TSA) – Gravity potential model – Spatial portioning – Thiession polygon.
Unit 5:	**3D and 4D modelling:** DTM / DEM - TIN and Grid – Contour – Slope -Hill shading – Watershed and Viewshed – Space and Time representation (4D) - Modelling: Soil erosion, Plume dispersion model – Surface water and Groundwater modelling – Urban distance decay.

Unit 6: Current Contours: Not for Examination Only for Discussion

Spatial autocorrelation, Spatial interpolation, Spatial regression, Spatial interaction

References:

1. Abler, R., Adams, J. S., and Gould, P., (1971). Spatial organization: The geographer's view of the World, Englewood Cliffs, N.J., Prentice-Hall. Englewood Cliffs.
2. Burrough, P. A. (1986). Principles of Geographical Information Systems for Land Resource Assessment. Oxford University Press Inc., New York.
3. Mitchell, a.., (1999). The ESRI Guide to GIS Analysis Volume 1: Geographical Patterns and Relationships, Environmental Systems Research Institute, Inc., Red Lands, California.
4. Mitchell, a.., Booth Bob, and Crosier Scott, (2002). ArcGIS Spatial Analyst Environmental Systems Research Institute, Inc., Red Lands, California.
5. Tsung Chang Kang, (2002). Introduction to Geographic Information Systems, Tata McGraw-Hill Publishing Company Limited, New Delhi.
6. Jay Gao (2021) Fundamentals of Spatial Analysis and Modelling, CRC Press, U.S.A
7. Francine by L. Dolins (2021) Spatial Analysis in Field Primatology: Applying GIS at Varying Scales Company, Lucknow
8. Michael Law (2021) Getting to Know ArcGIS Pro 2.8 Fourth Edition, ESRI Press, U.S.A
9. Wolf, P. R., and Dewitt, B. A., (2000), Elements of Photogrammetry: With Applications in GIS, McGraw-Hill.
10. Konecny, G., (2014), Geoinformation: Remote Sensing, Photogrammetry, and Geographic Information Systems (2nd Edition), CRC Press.

Web References:

1. https://foss4g.org/
2. https://bhuvan.nrsc.gov.in/

3. www.esri.com
4. https://www.qgis.org/en/site/

Course Outcomes:

Students will be able to:

1. Gain knowledge on Concept of spatial organization, Physical and relative space, Location and distance.
2. Gain knowledge on analysis of point entity includes distribution and density, Centrography, Near neighbourhood and reflexive neighbour.
3. Acquire knowledge on mapping density analysis (Isometry, Desymetry) and also point buffers.
4. analysis the line entity includes network topology, connectivity analysis, shortest path and total connectivity analysis.
5. Discuss on detour index and allocation assignment and accessibility and buffers.
6. Analysis the area entity / surface, Index of concentration and diversification and interpolation techniques.
7. Create maps, images, and apps to communicate spatial data in a meaningful way to others
8. Demonstrate organizational skills in file and database management.
9. Explore the Trend surface analysis (TSA), gravity potential model, and spatial portioning and Thiessen polygon.
10. Compare and analyze the 3D and 4D modelling.

Programme	M.Tech., Geoinformatics	Credits: 03
Course Code / Title	Python Programming	

Objectives

1. *To develop Python programs with conditionals, loops and functions.*
2. *To use Python data structures – lists, tuples, dictionaries.*
3. *To do input/output with files in Python*
4. *To use modules, packages and frameworks in python*

Unit 1:	**Basics of Python:** Introduction to Python: Python Introduction, History of Python, Python features, Python interpreter, Overview of programming in Python, Basic data types. Global and local variables - Basic Operators: Arithmetic Operators, Comparison Operators, Logical (or Relational) Operators, Assignment Operators, Conditional (or ternary) Operators.
Unit 2:	**Data types in Python:** Lists, Tuples, Sets, Strings, Dictionary, Modules: Module Loading and Execution – Packages – Making Your Own Module – The Python Standard Libraries.
Unit 3:	**Conditional Statements:** Conditionals: If-Else Constructs – Loop Structures/Iterative Statements – While Loop – For Loop – Break Statement- Continue statement – Function Call and Returning Values – Parameter Passing
Unit 4:	**File Handling and Exception Handling:** Files: Introduction – File Path – Opening and Closing Files – Reading and Writing Files –File Position –Exception: Errors and Exceptions, Exception Handling, Multiple Exceptions
Unit 5:	**Object Oriented Programming in Python:** Creating a Class, Class methods, Class Inheritance, Encapsulation, Polymorphism, class method vs. static methods, Python object persistence.

Unit 6: Current Contours: Not for Examination Only for Discussion

Python libraries - PyTorch, NumPy, TensorFlow, Matplotlib, Pandas, SciPy

References:

1. Guido van Rossum, Fred L. Drake Jr., "An Introduction to Python – Revised and Updated for Python 3.2, Network Theory Ltd., First edition, 2011
2. Reema Thareja, "Python Programming using Problem Solving Approach", Oxford University Press, First edition, 2017
3. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", Second Edition, Shroff, O'Reilly Publishers, 2016 (http://greenteapress.com/wp/thinkpython/
4. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and Expanded Edition, MIT Press, 2013
5. Charles Dierbach, "Introduction to Computer Science using Python", Wiley India Edition, First Edition, 2016
6. David Beazley (2013). Python Cookbook: Recipes for Mastering Python 3, O'Reilly Media, Inc
7. David Beazley (2009). Python Essential Reference, Addison-Wesley Professional.
8. Martin C. Brown (2009). Python: The Complete Reference, McGraw-Hill, Osborne.
9. Doug Hellmann (2011). The Python 3 Standard Library by Example, Addison-Wesley Professional.
10. Meenu Kohli (2021). Basic Core Python Programming, BPB Publications.

Web References:

1. Bugs.python.org
2. www.tutorialpoint.com
3. www.geeksforgeeks.org
4. https://docs.python.org/3/tutorial/
5. https://www.pythontutorial.net/

Course Outcomes:

Students will able to:

1. Develop algorithmic solutions to simple computational problems
2. Represent compound data using Python lists, tuples and dictionaries.

3. Read and write data from/to files in Python Programs
4. Structure simple Python programs using libraries, modules etc.
5. Structure a program by bundling related properties and behaviours into individual objects.
6. Demonstrate usage of data abstraction, encapsulation, and inheritance.
7. Handle files for creation and updation
8. Develop codes for handling exceptions and user warning messages
9. Perform object-oriented programming with the use of control structures, modularity, I/O. and other standard language constructs.
10. Apply the concepts and principles of the programming language to the real-world problems and solve the problems

Programme	M.Tech., Geoinformatics	Credits: 03
Course Code / Title	.NET Programming	

Objectives

1. *Understand the .NET Framework and the features*
2. *Distinguish desktop and web application development concepts and uses*
3. *Learn fundamental data types, statements, functions, and classes through OOP*
4. *Acquire knowledge in query statements and web pages*

Unit 1:	**Introduction to Microsoft.NET:** .Net Framework Architecture - Fundamentals- Common Language Runtime - CLR Architecture - Code compilation and Execution- Introduction to Visual Studio .Net - Form Design - Controls Design - Message box
Unit 2:	**Introduction to Windows Form**s: Form Properties - Variable - String Variables - Working with Forms - MDI Forms - Conditional statements - If statements - select case statements - Loops - For Loops - Do Loops - Arrays - VB Language Basics - Console Applications, Data Types - Statements & Blocks - Operators
Unit 3:	**C# Language Basics:** Introduction to C# - variables, data types, Array, operators and expressions - Control Statements - Loops - object oriented programming - Access Specifier - Overloading - inheritance and polymorphism - Windows form - Apply Inheritance techniques to Forms - Interfaces.
Unit 4:	**ADO.Net:** Benefits of ADO.NET - SQL - Namespaces - SQL Methods - Creating Tables –Insert –Update - Delete - SQL Connection object - SQL Command Object - Data Reader, Providers - Data Adapter Configuration - Data Set - Simple Binding - Data Grid View - Data Form Wizards - SQL Parameters.
Unit 5:	**ASP.NET:** Web forms in ASP.NET, States, Validation, Login; ASP.NET Administrative tasks ASP.NET Data controls, Ajax Extensions, LINQ, Working with XML data, Web Services.

Unit 6: Current Contours: Not for Examination Only for Discussion

Modules Creation; 3D Scripting in C#; Design and implement a simple AI; Sliver light; Web development

References:

1. Troelsen, A. (2008) Pro VB 2008 and the .NET 3.5 Platform, Apress, New York.
2. Walther, S. (2008) ASP.NET 3.5 Unleashed, Sams, Carmel.
3. Liberty, J. (2006) Learning Visual Basic .Net, O'Reilly Media, Sebastopol.
4. Harwani, B.M. (2010) Practical ASP.NET 3.5 Projects for Beginners, O'Reilly Media, Sebastopol.
5. Getting Started with ASP.NET 4.5 Web Forms and Visual Studio 2013 by Erik Reitan, Microsoft Press
6. Hands on with ASP.Net MVC - Covering MVC 6 (2015) by Rahul Sahay, C# Corner
7. Andrew Troelsen, (2022). Pro C# 10.0 with .NET 6: Foundational Principles and Practices in Programming, Apress.
8. Julia Lerman (2010). Programming Entity Framework, O'Reilly Media, Inc.
9. Jon Skeet (2008). C# In Depth. Dreamtech Press.
10. Ian Griffiths (2012). Programming C# 5.0: Building Windows 8, Web, and Desktop Applications for the .NET 4.5 Framework, O'Reilly Media, Inc.

Web References:

1. https://www.javapoint.com/vb.net-dot-net-framework
2. https://learn.microsoft.com/en.us/dotnet/cn-introduction
3. https://pluralsight.com/courses/windows-forms -introduction-with-visual basic
4. https://www.w3schools.com/cs/index.php
5. https://www.tutorialpoint.com/asp.net/asp.net-ado_net.

Course Outcomes:

Students will able to:

1. Acquire knowledge in .NET Framework and execution of compiler
2. Distinguish various controls and use them in application development

3. Understand OOP concepts and apply them in the application development
4. Develop applications for desktop and web platforms
5. Learn the fundamentals in database creation, queries, and CRUD commands
6. Find out how to connect to a database, read the information stored inside, and display it exactly the way you want
7. Program ADO .NET for working with data
8. Develop asynchronous application with the implementation of AJAX
9. Create Views in an MVC application that display and edit data and interact with Models and Controllers.
10. Develop a web application that uses the ASP.NET routing engine to present friendly URLs and a logical navigation hierarchy to users.

Programme	M.Tech., Geoinformatics	Credits: 03
Course Code / Title	Advances in Geospatial Technologies	

Objectives

1. *To understand the principles and components of Airborne Laser Terrain Mapping system*
2. *To plan for Airborne Laser Scanning Data Acquisition*
3. *To understand the concepts for generating DEM, DSM*
4. *To get exposed to various advanced technologies like Unmanned Aerial Vehicle, Ground Penetrating Radar and Multi criteria Decision Analysis.*

Unit 1:	**Airborne Laser Terrain Mapping (ALTM):** Principles of laser altimetry – components: GPS - IMU – LASER - data formats – strip adjustment – geometric correction –– ground point filtering - Digital Surface Model (DSM) –– Digital Elevation Model (DEM) – applications.
Unit 2:	**UAV Mapping and Application:** UAV Mapping – types – components – data processing – applications.
Unit 3:	**Ground Penetrating Radar (GPR):** Principles – components of GPR - electrical and magnetic properties of rocks – soil – fluids – survey methods; 2D survey – 3D survey.
Unit 4:	**Working Principles of GPR:** Data processing - analysis and interpretation – applications; Utility mapping – geo archaeology.
Unit 5:	**Multi-criteria Decision Analysis**: Elements of Multi-criteria Decision Analysis - classification, Spatial Multi-criteria Decision Analysis: Evaluation criteria – decision alternatives and constrain – criterion weighting – decision rules – sensitivity analysis –Multi-criteria Spatial Decision support system

Unit 6: Current Contours: Not for Examination Only for Discussion

3D terrain model; LiDAR Technology; Laser Surveying; Spatial Decision Support System

References:

1. Mathias Lemmens (2006) Laser Altimetry: Principles and Applications, CRC Press, London.
2. Karl Kraus (2007) Photogrammetry – Geometry from Images and Laser Scans, Walter de Gruyter, Berlin.
3. Ulaby, F.T., Moore,K.R. and Fung (1986) Microwave remote sensing, Addison-Wesley Publishing Company, London,
4. Lillisand. T.M, and Kiefer, P.W., (1998). Remote Sensing and Image Interpretation, John Wiley & Sons, New York.
5. Yuri Álvarez López and María García Fernández (2021) Advanced Techniques for Ground Penetrating Radar Imaging. MDPI, https://doi.org/10.3390/books978-3-0365-2150-3
6. Harry M. Jol (2009) Ground Penetrating Radar Theory and Applications, Elsevier Science, Amsterdam.
7. Michael Law (2021) Getting to Know ArcGIS Pro 2.8 Fourth Edition, ESRI Press, U.S.A
8. James B. Campbell, Randolph H. Wynne, Valerie A. Thomas (2022). Introduction to Remote Sensing, Guilford Press, New York
9. Ravi P. Gupta (2003) Remote Sensing Geology, Springer Berlin Heidelberg New York.
10. Jacek Malczewski (1999) GIS and Multicriteria Decision analysis, John Wiley & Sons, Inc, New York.

Web References:

1. https://www.geophysical.com/
2. https://www.geophysical.com/software
3. www.isprs.org
4. www.hexagongeospatial.com
5. https://libguides.utk.edu/c.php?g=898340&p=6463030

Course Outcomes:

Students will able to:

1. Explore the Airborne Laser Terrain Mapping (ALTM) and Principles of laser altimetry, components: GPS, IMU, LASER and data formats.

2. Quantify the Digital Surface Model (DSM), Digital Elevation Model (DEM) and its applications.
3. Familiar with the UAV components, types and applications.
4. Describe the applications of UAV in archaeology, urban mapping and disaster studies
5. Discuss the Principles, components and survey methods of Ground Penetrating Radar (GPR).
6. Understand the principles of 2D and 3D data acquisition
7. Handle the GPR Data processing, analysis and interpretation in processing environment.
8. Appreciate the GPR applications in Utility mapping and geo archaeology.
9. Evaluate decision rules in performing analysis
10. Apply the Multi-criteria Decision Analysis, classification and Spatial Multi-criteria Decision Analysis in GIS projects.

Programme	M.Tech., Geoinformatics	Credits: 03
	Semester III	
Course Code / Title	Web GIS	

Objectives

1. *Provide students with a comprehensive and up-to-date overview of Web GIS, including the basic concepts, principles, related fields (e.g., mobile GIS) and frontiers*
2. *Inspire students with the broad and real-world applications of Web GIS.*
3. *Provide students with the state-of-art technical skills to build Web GIS applications and the knowledge needed to choose from various Web GIS development options*
4. *Understand the functional model and capabilities of open-source GIS*

Unit 1:	**Concepts of GIS Data:** GIS data model-object vs Geodatabase - Relational database SQL/Postgress - Systems-extension of Relational models-for spatial address and objects (POST GIS) - Distributed database and TIER systems-client server architecture.
Unit 2:	**Trends in Data Management:** Database servers - Data mining concepts and applications- Dataware housing-indexing and catalysing services-metadata concepts and design.
Unit 3:	**Internet Technology in GIS:** Networking environment-data communication and Protocols- Distributed Computing-Grid computing and clusters-Internet map servers: Concepts and functions-map server applications-Data sharing concepts.
Unit 4:	**Web Technology:** Comparison of web GIG-client-side framework and web Browser server-side framework and web server-WLS, WMS, WFS services-web protection server-Map server and Geo Server relations-web GIS engineer-scripting type and main GIS: Java script, Ajax, PHP, Python scripting-on line GIS-mobile GIS.
Unit 5:	**Open GIS:** open-source technology options and limitations - Open foundations: OGC, GDAL, PROJ4, Geotools, FOSS4G – interoperability web GIS – Open sources: resources and tools.

Unit 6: Current Contours: Not for Examination Only for Discussion

Application of Web GIS in e-Government; Application of Web GIS in e-Business; 3D Web GIS; Internet mapping; Online GIS Analytics;

References:

1. Cartwright, W., Peterson, M. P., and Gartner G. (Eds) (2007), Multimedia Cartography, Springer, Berlin.
2. Pinde Fu (2020). Getting to Know Web GIS, Taylor and Francies, ESRI, U.S.A
3. Kraak, M., and Ormeling, F., (2003). Cartography: Visualization of Geospatial Data, Pearson Education, New Delhi.
4. Rene Rubalcava, (2014). ArcGIS Web Development, Simon and Schuster.
5. Kropla B., (2005). Beginning MapServer Open-Source GIS Development, Apress, New York.
6. Pinde Fu (2018). Getting to Know Web GIS, Esri Press.
7. Christian Harder (2017). The ArcGIS Book, Esri Press.
8. Paul A. Zandbergen (2017). Python Scripting for ArcGIS Pro, ESRI, U.S.A
9. Songnian Li, Suzana Dragicevic, Bert Veenendaal (2011). Advances in Web-based GIS, Mapping Services and Applications, CRC Press.
10. Tyler Mitchell, (2005). Web Mapping Illustrated: Using Open-Source GIS Toolkits, O'Reilly Media.

Web References:

1. https://foss4g.org/
2. https://mapserver.org/
3. http://webgis.pub/
4. https://libguides.utk.edu/c.php?g=1020425&p=7391962
5. https://www.qgis.org/en/site/

Course Outcomes:

Students will able to:

1. Acquire knowledge on GIS data model, Objects, Geodatabase and Distributed database.

2. Distinguish Client Server Architecture, Database Servers, Data mining and its applications.
3. Skilled in data warehousing and indexing, Metadata Concepts and Design.
4. Work with Internet Technology in GIS, Internet map servers and Applications of map server.
5. Develop applications in Client-Side Framework and Server-Side Framework.
6. Discuss on WLS, WMS, WFS services and Geo Server.
7. Differentiate web application and hosting platforms
8. Apply the different scripting types Java script, Ajax, PHP, Python scripting
9. Appreciate the Open-Source Technology Options and its Limitations, Open Foundations includes OGC, GDAL, PROJ4, Geotools, and FOSS4G.
10. Understand how open source software community functions and develops applications

Course Code / Title	Java Programming	

Course Objectives:

1. *Learn how to identify and design objects, classes, and their relationships to each other*
2. *Use links, associations, and Inheritance*
3. *Use diagram notation for use cases, class and object representation, links and associations, and object messages*

Unit 1:	**Object-Oriented Programming – Fundamentals:** Review of OOP - Objects and classes in Java – defining classes – methods - access specifiers – static members – constructors – finalize method – Arrays – Strings - Packages – Java Doc comments
Unit 2:	**Object-Oriented Programming – Inheritance:** Inheritance – class hierarchy – polymorphism – dynamic binding – final keyword – abstract classes – the Object class – Reflection – interfaces – object cloning – inner classes – proxies
Unit 3:	**Event-Driven Programming:** Graphics programming – Frame – Components – working with 2D shapes – Using color, fonts, and images - Basics of event handling – event handlers – adapter classes – actions – mouse events – AWT event hierarchy – introduction to Swing – Model-View- Controller design pattern – buttons – layout management – Swing Components
Unit 4:	**Generic Programming:** Motivation for generic programming – generic classes – generic methods – generic code and virtual machine – inheritance and generics – reflection and generics – exceptions – exception hierarchy – throwing and catching exceptions – Stack Trace Elements - assertions - logging
Unit 5:	**Concurrent Programming:** Multi-threaded programming – interrupting threads – thread states – thread properties – thread synchronization – thread-safe Collections – Executors – synchronizers – threads and event-driven programming

Unit 6: Current Contours: Not for Examination Only for Discussion

Google Cloud Platform, Java Development Kit, Android Application Project, Apache Tomcat

References:

1. Cay S. Horstmann and Gary Cornell (2008)"Core Java: Volume I – Fundamentals", Eighth Edition, Sun Microsystems Press
2. K. Arnold and J. Gosling (2000.) "The JAVA programming language", Third edition, Pearson Education, India
3. Timothy Budd (2000), "Understanding Object-oriented programming with Java", Updated Edition, Pearson Education, India
4. C. Thomas Wu (2006), "An introduction to Object-oriented programming with Java", Fourth Edition, Tata McGraw-Hill Publishing company Ltd., India
5. Roselyn Teukolsky M.S., Barron's (2015) AP Computer Science A, 7/e, USA
6. Marty Stepp, (2017)Programming Methodology, Stanford University, USA
7. John Smiley (2021) Learn to Program with Java, John Smiley Publishing , USA
8. Joshua Bloch, (2017) Effective Java, Addison-Wesley Professional, USA
9. Kathy Sierra, Bert Bates (2003) Head First Java, O'Reilly
10. Eric Freeman, Elisabeth Robson, Bert Bates, Kathy Sierra (2004) Head First Design Patterns, O'Reilly

Web References:

Online References:

1. https://www.computerscienceonline.org/cutting-edge/java/
2. http://www.learnjavaonline.org/
3. http://www.programming-simplified.com/index.html
4. https://www.codecademy.com/tracks/javascript
5. http://www.nptelvideos.com/java/java_video_lectures_tutorials.php

Course Outcomes:

Students will be able to:

1. Familiar with java syntax
2. write coding to analysis spatial data
3. understand the conceptual design of object-oriented programming
4. Appreciate the graphical programing feasibility in java
5. comprehended the Swing Components in Java
6. Using visibility modifiers (public, private, protected) to implement appropriate abstraction and encapsulation.
7. Describe the multi thread programming
8. Confident in applying Java in GIS environment
9. Integrate java script in web mapping
10. Apply in the open source engine (Google Earth) to process data

Course Code / Title	Regional Planning	

Course Objectives:

1. *To introduce the concepts of urban and regional planning*
2. *To explore the use of the geospatial technology in advanced analysis in planning.*
3. *To get exposure in modelling in urban land use and it's forecasting.*

Unit 1:	**Fundamentals:** Concepts of Urbanization and Urban Areas - concept of regions - formal and functional regions - census classification of urban areas - Planning Goals: Natural Resources Management; socioeconomic management and infrastructure planning - Planning physical structures and functional domains - data and information for urban and regional planning by Remote Sensing - Planning goals for urban areas and regions.
Unit 2:	**Inventory and Mapping:** Digital and image records of the Urban areas and Regions – classification of settlement patterns and structures – Segmentation of Built-up areas – Classification algorithms – Inventory of resources and measurements - Land use/ Land cover mapping – Deduction of sprawl, renewal and morphological changes – resolution of RS data in feature extraction and object delineation - mapping resources, developments and demography by choropleth and isopleth techniques - high resolution remote sensing data in urban analysis.
Unit 3:	**Assessment of Potentials:** Urban morphology – Housing typology – Population estimation from remote sensing – Infrastructure demand analysis – Land suitability analysis for Urban renewal – Plan formulation for sectoral and regional, development – Use of remote sensing and GIS in assessment, estimation and projections - Design of Urban and regional information systems – revenue and tax collection GIS - planning facilities and amenities.
Unit 4:	**Location-Allocation and Transportation Planning:** Site specific GIS: Housing development, parks and social facilities planning – urban and regional transportation corridors - wholesale and retail trade interactions - commuting-Classification of traffic – Optimum route and plans / shortest path – Alignment planning – Traffic and flow management – Accident analysis – case studies.
Unit 5:	**Modelling Techniques:** Urban growth modelling – GIS modelling - local and regional interaction potential- Expert systems in AM/FM planning – 3D city models – digital terrain of the urban areas and regions- DEM and socioeconomic – Land use Transportation interaction models – Intelligent transportation systems –Risk, vulnerability models in crime, accidents and disasters - case studies.

Unit 6: Current Contours: Not for Examination Only for Discussion

Regional imbalance, spatial data inventories, resources mapping, 2D and 3D data modelling

References

1. Juliana Maantay, John Ziegler, John Pickles,(2006) GIS for the Urban Environment, Esri Press
2. Allan Brimicombe (1997.) GIS Environmental Modelling and Engineering, CRC; 1 edition 2003. CRC Press, U.S.A.
3. Paul Longley, Michael Batty, (1997) Spatial Analysis: Modelling in a GIS Environment Wiley,
4. Michael F. Goodchild, Louis T. Steyaert, Bradley O. Parks, Carol Johnston, David Maidment, Michael Crane, Sandi Glendinning, (1996) GIS and Environmental Modelling: Progress and Research Issues (Hardcover) by, Publisher: Wiley, U.S.A
5. Roland Fletcher (2007) The Limits of Settlement Growth: A Theoretical Outline (New Studies in Archaeology) (First edition), Cambridge University Press;.
6. Said Easa, Yupo Chan, (1999) "Urban Planning and Development Applications of GIS",

Amer Society of Civil Engineers, U.S,A.
7. Harvey J. Miller, Shih-Lung Shaw, (2001), "Geographic Information Systems for Transportation: Principles and Applications (Spatial Information Systems)", Oxford University Press, USA
8. David J Maguire, Michael F Goodchild, Michael Batty,(2005) "GIS, Spatial Analysis, and Modelling", ESRI Press, U.S.A.
9. Peter Hall (2019) Urban and Regional Planning 6th edition by
10. Mukunda Mishra (2021)Regional Development Planning and Practice: Contemporary Issues in South Asia (Advances in Geographical and Environmental Sciences) , India

Web References:

1. http://www.esri.com/library/brochures/pdfs/gis-sols-for-urban-planning.pdf
2. http://research.iugaza.edu.ps/files/2278.PDF
3. https://library.ryerson.ca/gmdc/madar/gis/program/planning/
4. https://www.esri.com/library/bestpractices/urban-regional-planning.pdf
5. https://libguides.utk.edu/c.php?g=1020425&p=7391962

Course Outcome

Students will be able to:

1. Know the Concepts of Urbanization and Urban Areas and concept of regions
2. Learn the Natural Resources Management, socioeconomic management and infrastructure planning
3. Classify the settlement patterns and structures and also Segmentation of Built-up areas.
4. Understand about various Classification algorithms in Inventory and Mapping.
5. Discuss about the developments and demography by choropleth and isopleth techniques and high-resolution remote sensing data in urban analysis.
6. Know about urban morphology and Housing typology and also Assessment of Potentials.
7. Location-Allocation and Transportation Planning by using GIS
8. Understand plans and procedure for specific infrastructure development
9. Understand the necessary of multi-layers in regional development
10. Modelling Techniques for Regional Planning, 3D city models, Land use Transportation interaction models, Intelligent transportation systems and Risk, vulnerability models in crime, accidents and disasters related case studies

Decision Support System

Course Objectives:

1. *To impart the knowledge of Expert Systems, Fuzzy logic and DSS*
2. *Familiarize and make them understand the concepts of Object-oriented programming for Geomatics and its Applications.*
3. *Develop skills in GIS modelling*

Unit 1:	**Fundamentals:** Definition - Features, needs, components – characteristics –players - Expert system vs Conventional programming - Basic activities of ES - Structure and phases of building ES – Types – Rule based, Frame based & Hybrid – Concepts of Operations Research: linear programming and location - allocation concepts.
Unit 2:	**Knowledge Acquisition:** Knowledge Engineering – scope and levels of Knowledge – Methods of Knowledge Acquisition – Representation schemes - Rule, Semantic network, frames and logic – Inference Techniques – Types of Reasoning - deductive, inductive, adductive, analogical and non-monotonic - Case and model-based reasoning – conflict resolution - types of inference: forward and backward chaining.
Unit 3:	**Rule Based Expert Systems:** Evolution – Architecture – Examples – backward and forward chaining - rules and meta rules – rule-based systems – Case studies: MYCIN, PROSPECTOR – Integration of Rule based Expert system with GIS and Image Processing.
Unit 4:	**Inexact Reasoning:** Inferencing with uncertainty- Bayesian theory – Dempster Shafer Theory of evidence - examples – Certainty theory: overview, uncertain evidence, rule inferencing – certainty factors -– Fuzzy sets – Representation, hedges inference & fuzzy logic – image classification using fuzzy logic.
Unit 5:	**Modelling Techniques:** Urban growth modelling – GIS modelling - local and regional interaction potential- Expert systems in AM/FM planning – 3D city models – digital terrain of the urban areas and regions- DEM and socioeconomic – Land use Transportation interaction models – Intelligent transportation systems –Risk, vulnerability models in crime, accidents and disasters - case studies.

Unit 6: Current Contours: Not for Examination Only for Discussion

Use of DSS in Business sector, Clinical Decision Support Systems (CDSS), Decision support systems for crisis management, Case studies on DSS and its applications

References

1. Peter Jackson, (2004) Introduction to Expert systems, Pearson Education, India
2. Turban E.(2004) Expert Systems and Applied Artificial Intelligence, Macmillan, U.S.A
3. Donald A. Waterman (2001), A Guide to Expert systems, Pearson Education, India
4. Durkin.J (1994), Expert Systems Design and Development, Prentice Hall, India
5. Dan. W. Patterson,(2003) Introduction to Artificial Intelligence and Expert systems, Prentice Hall, India
6. Ermine.J.I,(2003) Expert Systems: Theory and Practice, Prentice Hall, India
7. Ramanathan Sugumaran, John DeGroote; Spatial Decision Support Systems: Principles and Practices, 2010 CRC Press
8. Prithvish Nag and Smita Sengupta (2007) Introduction to Geographical Information Systems, Concept Publishing Company., India
9. Blokdyk (2020) Decision Support System A Complete Guide by Gerardus, Art of Service, U.S.A
10. Susmita Bandyopadhyay (2022) Decision Support System, Tools and Techniques 1st Ed, CRC Press, U.S.A,

Web References:

1. https://www.tutorialspoint.com/management_information_system/decision_support_system.htm
2. http://www.ndwrcdp.org/documents/WU-HT-03-35/DSS%20Tutorial.pdf
3. https://www.wisdomjobs.com/e-university/management-information-systems-tutorial-322/mis-decision-support-system-25417.html

4. http://www.academia.edu/9889300/Decision_Support_Systems_Current_State_and_Development_Trends

Course Outcome

Students will be able to:

1. Discuss on the basics, components, and the activities of Expert System.
2. Describe about Structure and phases of building ES and Its types.
3. Understand about Knowledge Acquisition, Methods, and Its representation schemes.
4. Learn about Inference Techniques and Types of Reasoning.
5. Impart Skills on Rule Based Expert Systems
6. Get exposure on Inexact Reasoning
7. Learn about Object Based Expert System
8. Discuss on case studies in Geomatics

Project Management

Course objectives:

1. *The students would acquire basic know-how about time management, cost management, resource management and quality management to handle GIS projects*
2. *The students familiar to design and execution of projects in GIS-ICT industry *
3. *Understand time and scope management of a project*

Unit 1:	What is Project-Project Attributes-Project Management Knowledge Area-Project Management Tools and Techniques-Project Success Factors-Geoinformatics Projects-Corporate or Enterprise GIS-Health GIS –Census GIS –GIS Strategy Plan –Needs, Assessment and Requirement Analysis.
Unit 2:	Problems of GIS Research –Identification of Problem of Regional and Local Level-Geographical Data Source and Nature of Data to Be Used –Preparation of Field Report-Spatial Data-Classification and Sampling Problem-Project Phase and Project Lifecycle-Project initiation-Project Planning-Project Execution-Project Monitoring and Controlling
Unit 3:	GIS Projects-Integration-Scope and Time Management-Scope Management- Scope Planning-Scope Management Plan-Scope Definition-Creating the Work Breakdown Structure-Approaches to Develop Work Breakdown Structure-Time Management –Network Diagram-Activity Resource Estimation-Activity Duration Estimation-Cost Management-Project Quality Management
Unit 4:	PERT and CPM: Introduction-Development of Project Network-Time Estimation-Determination of the Critical Path-PERT Model-Measures of Variability-CPM Model-Responsibility and Team Work.
Unit 5:	The Importance of Project Risk Management –Risk Management Planning-Common Sources of Risk on GIS Projects-Risk Identification –Qualitative Risk Analysis-Risk Response Planning –Risk Monitoring and Control

Unit 6: Current Contours: Not for Examination Only for Discussion

Real Time Project Management, Internet of Things in Project Management, The Growing Influence of Project Management Tools, Agile Future in Project Management

References

1. Project Management Institute (1996) Project Management Body of Knowledge, PMI
2. Scott Berkun (2005) Art of Project Management, O'Reilly Media, Incorporated
3. Paige Baltzan (2016) Business driven information systems / Daniels College of Business, University of Denver, McGraw Hill Education, U.S.A
4. Thomas H. Davenport (2013) Enterprise analytics: optimize performance, process, and decisions through big data, Upper Saddle River, U.S.A
5. David L. Olson (2015) Information systems project management, New York: Business Expert Press, U.S.A.
6. Stanley E. Portny (2020) Project Management All-in-One For Dummies 1st Edition, U.K.
7. Chris Croft (2022) Project Management QuickStart Guide: The Simplified Beginner's Guide to Precise Planning, Strategic Resource Management, and Delivering World Class Results, ClydeBank Media LLC, U.K.
8. Burrough, P.A., and McDonnell, R.A., (2012), Principles of Geographic Information Systems, Oxford University Press.
9. Maguire, D.J., Goodchild, M.F., and Rhind, D.W., (1991), Geographic Information Systems, Longman Scientific and Technical.
10. Michael Law (2021)Getting to Know ArcGIS Pro 2.8 Fourth Edition, ESRI Press, U.S.A

Web References:

1. https://www.researchgate.net/.../273569026_Comparison_of_open_source_tools
2. https://www.softwaretestinghelp.com/requirements-management-tools/
3. https://project-management-software.financesonline.com/c/task-management
4. https://www.projectmanager.com/category/templates

Course Outcomes:

Students will be sable to:

1. Apply and critically evaluate the project management techniques and decision tools within constrained, ambiguous and uncertain business environments
2. Examine, analyze and synthesize the concepts, principles, processes and practice of project management
3. Assess the interrelationship between organizational strategy, innovation and change with project management
4. Identify the Input, tools, techniques and outputs defined in the four project stakeholder management processes
5. Solve simple network diagrams problems and perform basic scheduling calculations
6. Recognize the relationships among project, program, portfolio, and operational management
7. Design a project using participatory tools such as problem tree and stakeholder analysis
8. Determine ways to effectively integrate a project across an entire enterprise to reduce the impact of change.

Course Code / Title	Mapping Beyond Earth	

Objectives

1. *To introduce the students about the principles of planetary Remote Sensing and image acquisition systems*
2. *To aware the basic and modern space missions*
3. *To familiarize the concepts and resolutions of different remote sensing imaging on various planets in solar system*

Unit 1:	**UNIT I UNIVERSE AND SOLAR SYSTEM:** Origin of Universe - Big Bang and Steady state theories, Solar System - planets, satellites asteroids, meteorites and comets and internal differentiation of the planets- Planetary exploration mission and sensors.
Unit 2:	**UNIT II Lunar Studies:** Lunar orbiters - Sensors - Lunar Surface mapping – Indian and international missions
Unit 3:	**UNIT II Martian Studies:** Mars orbiters, Sensors, Mars Surface mapping – Indian and international missions
Unit 4:	**UNIT IV REMOTE SENSING FOR PLANETARY GEOLOGY** : Approaches to Remote Sensing analysis of the planetary surfaces; applications derived from interaction of electromagnetic radiation (X-ray, gamma-ray, visible, near-IR, mid-IR, radar).
Unit 5:	**UNIT V PLANETARY EXPLORATION MISSIONS:** Laser Altimetry and its application in Planetary science - Past, present and future missions - Analyses and Interpretation of data gathered through various missions: identification of morphological feature

Unit 6: Current Contours: Not for Examination Only for Discussion

Video imaging satellites, Real Time Observations, Unmanned Aerial Vehicles, Light weight Satellites

References:

1. Curran P.J (1985). Principles of Remote Sensing, Longman, London.
2. Lillisand T.M and R.W. Kiefer (1994). Remote Sensing and Image Interpretation (3rd edition). John Wiley & Sons, New York.
3. Sabins F.F Jr. (1987). Remote Sensing: Principles and Interpretation, W.H.Freeman & Co., New York.
4. James B. Campbell, Randolph H. Wynne, Valerie A. Thomas (2022). Introduction to Remote Sensing, Guilford Press, New York
5. Shuanggen Jin (2014)Planetary Geodesy and Remote Sensing 1st Edition, CRC PRESS, U.S.A
6. Bo Wu, Kaichang Di, Jürgen Oberst, Irina Karachevtseva (2018) Planetary Remote Sensing and
7. Mapping 1st Edition, CRC Press,U.S.A
8. Michael Jacobson (2005) Earth System Science, Elsevier Science
9. Timothy Lenton (2016) Earth System Science A Very Short Introduction, Oxford University Press
10. Brian J. Skinner, Barbara Winifred Murck (1996) The Blue Planet An Introduction to Earth System Science, Wiley

Web References:

1. https://learn.concord.org/earth
2. https://learn.concord.org/earth
3. https://serc.carleton.edu/introgeo/earthsystem/nutshell/courses.html
4. https://earth.stanford.edu/ess
5. https://www.ncl.ac.uk/module-catalogue/module.php?code=CEG1601

Course Outcomes:

Students will be sable to:

1. Discuss the principles and development of remote sensing and imaging systems focused to space.
2. Describe the principles and applications optical imaging system for mapping lunar surface
3. Describe the principles and applications hyperspectral imaging system for mapping lunar and Mars surface
4. Differentiate the image processing methods suitable for mineral mapping of lunar and mars surface
5. Articulate the surface morphology of Lunar and Mars surface
6. Increase the proficiency of understanding origin of surface morphology features of Lunar and Mars surface
7. Discuss the characteristics of rovers mapped the surface of Mars and Moon.
8. Understand of applications thermal remote sensing on planetary systems.

9. Acquire knowledge on applications of space telescope like James Web and Hubble. 10. Confident to handle different satellite data products pertaining to terrestrial planets.

Course Code / Title	Mapping Beyond Earth	

Objectives

1. *To introduce the students about the principles of planetary Remote Sensing and image acquisition systems*
2. *To aware the basic and modern space missions*
3. *To familiarize the concepts and resolutions of different remote sensing imaging on various planets in solar system*

Unit 1:	**Coastal Zone:** Coastal zone – Coastal zone regulations – Beach profile – Surf zone – Off shore –Coastal waters – Estuaries – Wet lands and Lagoons – Living resources – Non-living resources.
Unit 2:	**Platforms**: Costal management aspects – spatial , spectral, radiometric and temporal resolutions, sensors – ETM, IKONOS, SPOT XS, sea WIFS, ERS ,Along track scanning radiometer (ASTER), OCEANSAT,RADARSAT, MODIS, global open datasets – accuracies with different sensors, limitations.
Unit 3:	**Mapping of Coastal Processes:** Erosion and depositional shore features – Littoral currents – Coastal aquifers – Sea water intrusion – Impact of sewage disposal in seas.
Unit 4:	**Oceanographic Applications:** Use of Microwave data – CZCS studies – chlorophyll production index – various sensors used for coastal application – physical oceanographic parameter estimation – sea surface temperature – significant wave height – wind speed and direction – Oceanic Circulation – Tidal Variation – Sea Level Rise - Coastal Bathymetry.
Unit 5:	**ICZM**: Concepts and frame work of ICZM - Coastal Biodiversity – wetland management – mangrove eco system – coastal environmental impact assessment – Coastal Regulation zone mapping –sustainable development – case studies using Geospatial Technology.

Unit 6: Current Contours: Not for Examination Only for Discussion

Coastal disasters, Demographic dynamics in coastal areas, Ocean and costal observation satellites, ICZM and Indian Coastal Regulation

References:

1. Richard Sylvester (1999), Coastal Engineering, Volume I and II, Elsevier Scientific Publishing Co., Dwivedi, S.N., Natarajan, R and Ramachandran, S (1991) Coastal Zone Management in Tamil Nadu, Tamil Nadu.
2. Wolf. P.R., (2014). Elements of Photogrammetry with Application in GIS, McGraw Hill books Co., London.
3. Curran P.J (1985). Principles of Remote Sensing, Longman, London.
4. Lillisand T.M and R.W. Kiefer (1994). Remote Sensing and Image Interpretation (3rd edition). John Wiley & Sons, New York.
5. Ramamohana Rao P, P Suneetha (2014) Coastal Zone Management Using Remote Sensing and GIS, LAP Lambert Academic Publishing
6. Ramkumar Mu, Arthur James, David Menier, Kumaraswamy K (2014) Coastal Zone Management: Global Perspectives, Regional Processes, Local Issues, Elsevier
7. Ramkumar Mu. , K Kumaraswamy, R. Mohanraj (2015)Environmental Management of River Basin Ecosystems, Springer :Earth System Sciences, Springer
8. Burrough, P.A., and McDonnell, R.A., (2012), Principles of Geographic Information Systems, Oxford University Press.
9. Chang, K. T., (2006), Introduction to Geographic Information Systems, Tata McGrawHill.
10. Ramkumar Mu, David Menier (2017) Eustasy, High-Frequency Sea Level Cycles and Habitat Heterogeneity, Elsevier

Web References:

1. https://projects.worldbank.org/en/projects-operations/project-detail/P097985
2. www.nrsc.gov.in
3. https://sicom.nic.in/projects/iczm-project-phase-1/origin-iczm

4. https://www.nio.org/

Course Outcomes:

Students will be sable to:

1. Describe the coastal geomorphic features and ecosystems.
2. Understand Coastal zone, Beach profile, Surf zone and offshore.
3. Discuss the optical remote sensing potential to ocean and coastal zone observations.
4. Familiar with the microwave and optical remote sensing potential and limitations to ocean and coastal zone observations.
5. Acquire knowledge to visualize, the spatial data.
6. Describe the methods and application of information delivery and cartographic presentation on mobile devices.
7. Describe the applications of CZCS in chlorophyll and algal mapping
8. Appreciate the sensors for coastal bathymetry
9. Handle is issues like costal sustainable management (SDG)
10. Justify the amendments given by state and central government regarding Coastal regulations.

Course Code / Title	Natural Resources Management	

Course Objectives:

4. *To provide exposure to students in gaining knowledge on concepts and applications*
5. *Lead to modelling of earth resources management using Remote Sensing and GIS technologies.*
6. *Develop skills to monitor and visualize risks for proper resources management*

Unit 1:	**Concept of Resources:** Concepts, classification, and appraisal- Natural resources – natural resource economics - management of natural resources-Sustainability and resources management -SDG
Unit 2:	**Resource Assessment-I**: Multi Criteria Modelling - Land evaluation methods- land classification methods-soil and water conservation- land use and Land cover mapping- land utilization- sustainable land use planning and sustainable development
Unit 3:	**Resource Assessment-II**: sustainable water resource assessment- watershed analysis and management-coastal and ocean resources and management- fisheries management
Unit 4:	**Risk assessment:** Multi Criteria Modelling - Wildlife, forest, recreational, agricultural and rangeland assessment - Ecological Risk Assessments - Natural Resource Damage Assessments- damage of natural resources
Unit 5:	**Natural resource surveys and monitoring**– strategies for sustainable natural resource management- millennium eco-system assessment project-resources utilization and conservation in India - case studies of Natural Resources Management with Geoinformatics applications.

Unit 6: Current Contours: Not for Examination Only for Discussion

Application of GIS/RS in soil erosion assessment and prediction, Application of GIS/RS in morphological changes and hydrology of rivers, Application of GIS/RS in water pollution., Application of GIS/RS in river and coastal erosion modelling, Application of GIS/RS in industrial development planning

References:

1. Holechek, J. L., R. A. Cole, J. T. Fisher, and R. Valdez (2003) Natural Resources: Ecology, Economics and Policy (2nd Edition). Prentice Hall Education.
2. Knight, Richard L., and Sarah F. Bates (1995). A New Century for Natural Resource Management. Island Press Publishing.
3. Lilesand and Keifer (2000): Introduction to remote sensing and Image Interpretation; John Willy & sons Ltd., New York.
4. Colin W. Mitchell (1991) Land Evaluation, Longman scientific& Technical, co published with John Wiley & sons Inc, New York.
5. Burrough, P.A. (1986). Principles of Geographical Information Systems for Land Resource Assessment, Clarendon Press, Oxford, New York.
6. Kevin H. Deal (2020) Wildlife and Natural Resource Management 4th Edition, atithibooks, New Delhi
7. Brian D. Fath, Sven Erik Jorgensen (2020) Managing Water Resources and Hydrological Systems, CRC Press, U.S.A
8. Ramkumar, Mu, (2009) Geological Hazards: Causes, Consequences and Methods of Containment, New India Publishing Agency, New Delhi.
9. Brian Tomaszewski (2020) Geographic Information Systems (GIS) for Disaster Management, Routledge, U.K.
10. Lyon, J.G (2003) GIS for Water Resources and Watershed Management. Taylor and Francis, New York.

Web References:

1. www.esri.com/en-us/industries/natural-resources/overview

2. www.sdgs.un.org/goals
3. www.tnsdg.tn.gov.in/
4. www.sdgindiaindex.niti.gov.in/
5. www.nrsc.gov.in

Course Outcomes:

Students will be sable to:

1. Discuss the concepts, classification and appraisal of Natural resources.
2. Describe the significance of natural resources management and Sustainability.
3. Appreciate the Land evaluation methods, land classification methods and soil and water conservation.
4. Discuss on land use and Land cover mapping, land utilization, sustainable land use planning and sustainable development.
5. Describe the sustainable water resource assessment and watershed analysis and management.
6. Carryout resource survey and monitor resources
7. Prepare resources inventories and evaluation and preservation
8. Familiar about coastal and ocean resources and management and fisheries management.
9. Appreciate the implementation of SDG at State and National level at different scenarios.
10. Discuss to gain knowledge on Natural resource surveys and monitoring and case studies of Natural Resources Management with Geoinformatics applications

Course Code / Title	Coastal Zone Studies	

Objectives

1. *To introduce the students about the principles of planetary Remote Sensing and image acquisition systems*
2. *To aware the basic and modern space missions*
3. *To familiarize the concepts and resolutions of different remote sensing imaging on various planets in solar system*
4. *To understand the Indian and international space missions to explore the planetary system*

Unit 1:	**Coastal Zone:** Coastal zone – Coastal zone regulations – Beach profile – Surf zone – Off shore –Coastal waters – Estuaries – Wet lands and Lagoons – Living resources – Non-living resources.
Unit 2:	**Platforms**: Costal management aspects – spatial , spectral, radiometric and temporal resolutions, sensors – ETM, IKONOS, SPOT XS, sea WIFS, ERS ,Along track scanning radiometer (ASTER), OCEANSAT,RADARSAT, MODIS, global open datasets – accuracies with different sensors, limitations.
Unit 3:	**Mapping of Coastal Processes:** Erosion and depositional shore features – Littoral currents – Coastal aquifers – Sea water intrusion – Impact of sewage disposal in seas.
Unit 4:	**Oceanographic Applications:** Use of Microwave data – CZCS studies – chlorophyll production index – various sensors used for coastal application – physical oceanographic parameter estimation – sea surface temperature – significant wave height – wind speed and direction – Oceanic Circulation – Tidal Variation – Sea Level Rise - Coastal Bathymetry.
Unit 5:	**ICZM**: Concepts and frame work of ICZM - Coastal Biodiversity – wetland management – mangrove eco system – coastal environmental impact assessment – Coastal Regulation zone mapping –sustainable development – case studies using Geospatial Technology.

Unit 6: Current Contours: Not for Examination Only for Discussion

- Coastal disasters
- Demographic dynamics in coastal areas
- Ocean and costal observation satellites
- ICZM and Indian Coastal Regulation

References:

11. Richard Sylvester (1999), Coastal Engineering, Volume I and II, Elsevier Scientific Publishing Co., Dwivedi, S.N., Natarajan, R and Ramachandran, S (1991) Coastal Zone Management in Tamil Nadu, Tamil Nadu.
12. Ramamohana Rao P, P Suneetha (2014) Coastal Zone Management Using Remote Sensing and GIS, LAP Lambert Academic Publishing
13. Ramkumar Mu, Arthur James, David Menier, Kumaraswamy K (2014)Coastal Zone Management: Global Perspectives, Regional Processes, Local Issues, Elsevier
14. Ramkumar Mu. , K Kumaraswamy, R. Mohanraj (2015)Environmental Management of River Basin Ecosystems, Springer :Earth System Sciences, Springer
15. Ramkumar Mu, David Menier (2017) Eustasy, High-Frequency Sea Level Cycles and Habitat

Heterogeneity, Elsevier

Web References:

1. www.nasa.gov
2. https://projects.worldbank.org/en/projects-operations/project-detail/P097985
3. www.nrsc.gov.in
4. https://sicom.nic.in/projects/iczm-project-phase-1/origin-iczm
5. http://iirs.gov.in
6. https://www.nio.org/
7. https://www.niot.res.in/

Course Outcomes:

Students will be able to:

11. Describe the coastal geomorphic features and ecosystems.
12. Understand Coastal zone, Beach profile, Surf zone and offshore.
13. Discuss the optical remote sensing potential to ocean and coastal zone observations.
14. Familiar with the microwave and optical remote sensing potential and limitations to ocean and coastal zone observations.
15. Describe the applications of CZCS in chlorophyll and algal mapping
16. Appreciate the sensors for coastal bathymetry
17. Handle is issues like costal sustainable management (SDG)
18. Justify the amendments given by state and central government regarding Coastal regulations.

Programme	M.SC. GEOGRAPHY (FIVE-YEAR INTEGRATED) PROGRAMME	Credits:02
	Semester II	
Course Code / Title	GV026 - ENVIRONMENTAL STUDIES	

Objectives

1) *This course aimed to discuss about the importance of environmental studies.*
2) *The course describes about the functions of environment around us.*
3) *Learners can acquire knowledge on different ecosystems.*
4) *The course discusses the relation between the human and environment.*

Unit: 1	**Introduction:** Definition, nature, scope and importance of environmental studies - Need for public awareness on environment - Natural Resources: Forest resources, Water resources, Mineral resources, Energy resources, Land resources, Food resources - Renewable and non-renewable resources - Natural resources and associated problems - Role of an individual in conservation of natural resources – sustainable development.
Unit: 2	**Ecosystems:** Concept of an ecosystem - Structure and function - Energy flow in the ecosystem - Food chains, food webs and ecological pyramids – Characteristic features and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems - **Biodiversity**: Biodiversity and its conservation - Hot-spots of biodiversity - Threats to biodiversity - India as a mega-biodiversity nation - Endangered and endemic species of India - In-situ and Ex-situ conservation of biodiversity.
Unit: 3	**Environmental Pollution**: Definition –types, causes, effects and controls measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, and Nuclear hazards - Role of an individual in prevention of pollution – **Solid waste management:** Causes, effects and control measures of urban and industrial wastes - **Disaster management**: floods, earthquake, cyclone, landslides, Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.
Unit: 4	**Social Issues and the Environment**: Urban problems related to energy - Water conservation, rainwater harvesting, watershed management - Resettlement and rehabilitations of people; its problems and concerns - Wasteland reclamation - Consumerism and waste products. Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act. Issues involved in enforcement of environmental legislation - Public awareness.
Unit: 5	**Human Population and the Environment:** Population growth, variation among nations - Population explosion - Family Welfare Programme - Environment and human health – Human rights – Environmental Education - HIV/AIDS - Women and Child Welfare - Role of Information Technology in Environment and human health - Field work: Visit an ecosystem to study and document environmental assets – Visit a local polluted site.

Unit: 6 Current Contours: Not for Examination Only for Discussion

- SardarSarovar Project-Sariska Tiger Reserve-RajasthanOrissa – Olive Ridley Turtles-A case study of pesticide pollution in India - Bhopal Gas Tragedy-Global Warming and Climate Change – Food Waste –Biodiversity Loss – Plastic Pollution – Melting Ice Capes and Sea Level Rise – Ocean Acidification – Fast Fashion Textile Waste etc.

References:

1. Abhik Gupta, Susmita Gupta (2021) Environmental Studies: Principles and Practices, SAGE Publications Pvt. Ltd; 1st edition
2. Bharucha, E., (2003) Textbook for Environmental Studies, UGC, New Delhi and BharatiVidyapeeth, Pune.

3. Chandna R. C., (2002) Environmental Geography, Kalyani, Ludhiana.
4. Chiras D. D. and Reganold J. P., (2005) Natural Resources Conservation: Management for a Sustainable Futures, Prentice Hall.
5. Cunninghum W. P. and Cunninghum M. A., (2004) Principals of Environmental Science: Inquiry and Applications, Tata Macgraw Hill, New Delhi.
6. Goudie A., (2001) The Nature of the Environment, Blackwell, Oxford.
7. Kumaraswamy, K., Alagappa Moses., A &Vasanthy, M. (2004) Environmental Studies, Bharathidasan University, Tiruchirappalli
8. Kumaraswamy.K (2021),A Comprehensive Textbook for Environmental Studies, New century book house (P) Ltd, Chennai.
9. Miller G. T., (2004): Environmental Science: Working with the Earth, Thomson BrooksCole, Singapore.
10. Odum, E. P. et al, (2005): Fundamentals of Ecology, Ceneage Learning India
11. Saxena, H.M., (2012) Environmental Studies, Rawat Publications, Jaipur.
12. UNEP, (2007) Global Environment Outlook: GEO4: Environment for Development, United Nations Environment Programme.

Web source

1. *https://www.sbsc.in/pdf/resources/1588750812_Unit_1_Introduction_to_environmental_studies.pdf*
2. *https://sc-s.si/joomla/images/Ecosystems.pdf*
3. *https://www.who.int/news-room/fact-sheets/detail/biodiversity-and-health*
4. *https://elaw.org/system/files/Chapter%208%20Disaster%20Management.pdf*
5. *https://www.svce.ac.in/wp-content/uploads/2021/01/EVS-UNIT-4.pdf*

Course Outcomes:

On completion of the course the student will:

1. *Able to understand the importance of environment.*
2. *Gain knowledge about various resources available in the ecosystem.*
3. *Acquire knowledge about the functions and processes in various ecosystems.*
4. *Understand about the importance of biodiversity and essentials of it conservation.*
5. *Acquire knowledge on various disaster and it impacts on environment.*
6. *Get the information about various pollution and pollutants.*
7. *Understand the different environmental Acts and its importance..*
8. *Articulate the interdisciplinary context of environmental issues*
9. *Recognize the relation between human and environment.*
10. *Achieve the consciousness of environment and wildlife conservation through this course.*