University of Pune **Department of Geography**

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Syllabus of the M.Sc. Course in Geoinformatics

Structure of the course

Semester I:

Course Code	Course Title	Credits per course	Total credits to be completed in the semester
	Concepts in Geography	*	
GE101	Introduction to Remote Sensing	5	
GE102	Introduction to Geographic Information System	5	
GE103	Practical in Cartography and Map interpretation	5	
GE104	Practical in GIS and GPS	5	
GE105	Practical in Photo and image interpretation	5	
			25

Semester II:

GE201	Digital Image Processing	5	
GE202	Spatial Analysis	4	
GE203	Practical in Statistical Methods	5	
GE204	Practical in Digital Image Processing	5	
GE205	Practical in Spatial Analysis	6	
	Pilot Project	*	
			25

Semester III:

GE301	Advances in GIS and RS	5	
GE302	Application of RS and GIS (Part I)	5	
GE303	Application of RS and GIS (Part II)	5	
GE304	Practical in Advanced RS and GIS	5	
GE305	Practical in Programming and Customization	5	
			25

Semester IV:

GE401	Project Work	25	
			25

* Non-credit courses

Total Duration of the course: **2 Years**

Total Credits for the course: **100**

Syllabus of M.Sc. Course in Geoinformatics

Semester I Course GE 101
Introduction to Remote Sensing: Theory 5 credits

1	**Principles of remote sensing**	Definition, historical perspective, development of RS in India, Stages in RS EMR and EMR spectrum, EMR quantities Theories of EMR, Concept of black body, Laws of radiation, Hemispheric reflectance, transmittance, absorptance	
2	**Interaction of EMR**	with the earth surface: reflection, transmission, Spectral signatures with the atmosphere: scattering, absorption, refraction, Atmospheric windows and types of RS	Credit 1
3	**Physical basis of Signature**	Signature in the Reflective OIR Region Vegetation. Soil, Water bodies/Ocean	Credit 1
4	**Fundamentals of aerial photography**	Scale, resolution, projection, flight planning, overlaps, Geometric characteristics of aerial photographs, Measurement of scale and height on aerial photographs	Credit 1
5	**Platforms and Orbits**	Platforms: ground-based, air-borne, space-borne, Orbits: Geostationary satellites and Polar-orbiting satellites	
6	**Sensors**	Quality of image in Optical Systems, Imaging Mode, Photographic Camera, Television Cameras, Opto Mechanical Scanners, Opto Mechanical Scanners operated from satellites, Pushbroom cameras, Hyper Spectral imager	Credit 1
7	**Data products**	Data formats, Ground Segment Organisation, Data Product generation, Referencing Scheme, Data Products output medium: Photo products and Digital products	Credit 1
8	**Visual Image Analysis**	Factors governing the interpretability Elements of image interpretation	

Reference Books:

1] Fundamentals of Remote Sensing by George Joseph, Published by Universities Press (India) Private Limited, 2004.
2] Remote Sensing and Image interpretation by Lillesand T. M., Kiefer R. W, Published by John Wiley & Sons Inc, 2000.
3] Introduction to Remote Sensing by Campbell James, Published by Taylor & prancis London.
4] Textbook on Remote Sensing by Agarwal C.S, Published by Wheeler A. H., 2000
5] Lecture notes, Module **I** , Photogrammetry and Remote Sensing, IIRS.
6] Remote Sensing by Agarwal by C.S. and Garg, P. K. (2000):, A. H. Wheeler and Co. Ltd., New Delhi.

Course GE 102
Introduction to Geographic Information System: Theory - 5 credits

1	**Introduction to GIS**	Definitions, Evolution, Components, Objectives.	
2	**Hardware & Software requirements**	Hardware: Basic blocks of Computer, Processor, memory, RAM/ROM, Secondary storage devices. Input/Output devices, Peripherals, Binary number system, data & instructions, Working of computer. Software: Operating systems, Application compilers, editors. Overview of GIS software packages available in the market	Credit 2
3	**Geographic data**	Types of data, Levels of measurements	
4	**Spatial data**	Concept of space & time, layers & coverages, spatial data models, Representation of geographic features in vector & Raster models, point, line, polygon. Concept of arc, nodes, vertices and Topology. Object oriented models: advantages & disadvantages, Computer Representation for storing spatial data, block code, run length encoding, Chain code, Quadtree, Issues governing choice of models.	Credit 1
5	**Non-Spatial data**	Advantages of Data base management systems. Conceptual & Implementational models, Hierarchical, Network & Relational models. RDBMS: components, concept, Data base schema, Tables, relationships-one to one, one to many, many to many. Data base design & Normalization, (1NF, 2NF, 3NF forms) Data definition & manipulation using SQL SQL – query processing, operations on tables, Union, Intersection., Product, Natural Join., Integrity constraints, data base security, Role of Data Base Administrator(DBA)	Credit 1
6	**Spatial data input**	Digitization, error identification, types and sources of errors, correction, editing , topology building	Credit 1

Reference Books:

1] Geographical Information Science, Reference Material, Volume I by Roy P. S., Published by IIRS, 2000.
2] Principles of Geographical Information Systems by Burrough P. A. MacDonneli R. A., Published by Oxford University Press, 2000.
3] Concepts and Techniques of Geographical Information Systems by Lo. C. P., Yeung A.W., Published by Prentice- Hall of India Pr. Ltd., 2002
4] An Introduction to Geographical Information Systems by Heywood I., Cornelius S., Carrer S., Published by Pearson Education Pvt. Ltd, 2002.
5] Introduction to Geographical Information System by Kang-stung-Chang, Published by Tata McGraw Hill Pub. Comp, 2002.
6] The GIS Book by Korte G.B., Published by Onward Press, 2001
7] Fundamentals of Geographic Information Systems, by Demers M.N., Published by John Wiley & Sons, 2000.

Course GE 103
Practical in Cartography and Map Interpretation: 5 Credits

1	**Map scale**	Types and conversion, vertical exaggeration, enlargement and reduction	Credit 1
2	**Map projection**	Concept, Classification, Uses Types: Polyconic projection; Mercator projection (UTM)	
3	**Representation of statistical data**	I) Choropleths, Isopleths, Dots II) unimodal, two-dimensional and three-dimensional diagrams	Credit 1
4	**Introduction to SOI topographical maps-**	Numbering, scales, grid reference, signs and symbols, color system	Credit 1
5	**Relief representation techniques**	Profiles and Identification and representation of landforms from toposheets of fluvial, coastal, aeolian and glacial landscapes	Credit 1
6	**Interpretation**	Study and interpretation of SOI maps Study and interpretation of cadastral and thematic maps	Credit 1

Reference Books:

1] Elements of Practical Geography by R. L Singh, Published by Kalyani Publishers, 1979
2] Geographical Interpretation of Indian Topographical Maps by Tamaskar B. G., Deshmukh V. M., Orient Longman Ltd, 1974
3] Applied General Statistics by Croxton F. E., Cowden, D. J. and Klein, S. Pretice- Hall of India 1975.
4] Frank, H. and Althoen, S.C., statistics Cocepts and Applications, Cambridge University Press, 1994.
5]): An Introduction to Quantitative Analysis in Human Geography by Yeates, M., McGrraw-Hill, 1974.
6] Map Interpretation by Ramamurthy, K., Rex Printer, Madras, 1982.
7] Index to a set of sixty topographic maps illustrating specified physiographic feature by Vaidyanadhan, R., 1968.
8] Working with maps by Gupta K K and Tyagi, V.C, Survey of India Publication, 1992.
9] Geographical Interpretation of Indian Topographical maps by Tamaskar, B.G. and Deshmukh, V. M., Orient Longman, 1974..
10] Understanding Map Projection, GIS by ESRI, 2003-2004, USA

Course GE 104
Practical in GIS and GPS: 5 credits

1	**Attribute data input**	Creation of schema, tables, data definition, data input, data updating, queries on tables, simple- complex query with two or more tables using SQL., queries using Union, Intersection, Join etc. operations. Use of M.S. Excel and Access. Project work	Credits 2
2	**Spatial data input**	With Autocad Map software. Scanning, on screen digitization, editing, topology creation, linear & area measurements, linking of attribute data with geographic features, Project work	Credits 2
3	**GPS**	Concepts, types, modes of coordinate collection, GPS survey, inputting GPS data into computer.	Credits 1

Reference Books:
1] Introduction to Global Positioning System by Ahmed E I and Rabbany, Published by Artech House Boston London
2} Geographical Information Science, Reference Material, Volume I by Roy P. S., Published by IIRS, 2000.

Course GE 105
Practical in Photo and Image Interpretation: 5 credits

1	**Measurements**	Determination of scale and height on aerial photograph	Credit 2
2	**Interpretation**	Interpretation of single vertical aerial photographs Interpretation of stereo-pair of aerial photograph	
3	**Satellite images**	Reference system of IRS satellites	Credit 2
4	**Interpretation**	Interpretation of Satellite images derived from PAN, LISS, WiFS, OCM sensors Study and Visual Interpretation of satellite images for Physical features , Urban, Forest and Agricultural landuse	
5	**Field Work**	Study tour: Identification of features in the field using aerial photographs and satellite images	Credit 1

Reference Books:
1] Fundamentals of Remote Sensing By George Joseph, Published by Universities Press (India) Private Limited, 2004.
2] Remote Sensing and Image interpretation by Lillesand T. M., Kiefer R. W, Published by John Wiley & Sons Inc, 2000.
3] Remote Sensing by Agarwal, C.S. and Garg, P. K., A. H. Wheeler and Co. Ltd., New Delhi, 2000.

Semester II Course GE 201
Digital Image Processing: Theory - 5 credits

1	**Introduction to digital image processing**	Digital images Sources of Errors: Radiometric and Geometric, Image rectification: geometric correction, radiometric correction, noise removal	Credit 1
2	**Image enhancement techniques**	Contrast enhancement: Linear and Non-linear Logarithmic contrast enhancement, Exponential contrast enhancement, Gaussian Stretch,Density slicing, Spatial filtering: Low frequency and High frequency, Edge enhancement Band ratioing, Band Combination	Credit 2
3	**Digital image classification**	Classification Scheme: Supervised classifation: Training sites selecton and statistical information extraction, Discriminant Functions; Maximum Likelihood classifier, Euclidian distance, Mahalanobis distance; Unsupervised classifiacton, Classification accuracy assessment, Error matrix	Credit 2

Reference Books:

1] Remote Sensing Digital Image Processing by Richards J. A, Xiuping Jia, Published by Springer Verbg Berline Heidelberg My. 1999
2] Digital Image Processing and Analysis by Chanda B., Dattaa D , Majumdar , Published by Prentice- Hall of India , Feb 2001
3] Digital Remote Sensing by Prithvish Nag and M. Kudrat , Concept Publishing Company, New Delhi- 110059, 1998
4] Lecture notes module **II**, Image Analysis and Interpretation, IIRS

Course GE 202
Spatial analysis: Theory – 4 credits

1	**Introduction to Spatial analysis**	Significance of spatial analysis. Overview of tools for analysis	Credit 1
2	**Spatial analysis Vector based**	Overlay operations, point in polygon, line in polygon, polygon in polygon, Single layer operations: feature identification, extraction, classification and manipulation. Multilayer operations: Union, Intersection, Difference	
3	**Spatial analysis Raster based**	Map algebra, grid based operations, Local, Focal , Zonal & Global functions, Cost surface analysis, Optimal path and proximity search	Credit 1
4	**Network analysis**	Concepts, evaluation of network complexity using alpha, gamma indices. C- matrices for evaluating connectivity of the network. network data model.	
5	**Point pattern analysis**	Methods for evaluating point patterns: clustered and random distribution	Credit 1
6	**Surface analysis**	Interpolation methods, DEM, TIN, variance filter, slope and aspect, relief and hill shading	
7	**Spatial modeling**	Role of spatial model, explanative, predictive and normative models. Correlation-regression analysis in model building. Handling complex spatial query, Case studies.	Credit 1

Reference Books:

1] Geographical Information Science, Vol. I by Roy P. S., Published by IIRS, 2000.
2] Fundamentals of Geographic Information Systems, Second Edition by Demers M.N., Published by John Wiley & Sons, 2000.
3] Principles of Geographical Information Systems by Burrough P. A. MacDonneli R. A., Published by Oxford University Press, 2000.
4] GIS and Multi-criteria Analysis by Makrewski Jacek, USA, 1999

Course GE 203
Practical in Statistical methods: 5 Credits

1	Geographic data :	Sources, types, organization of data, discrete and continuous series, scale of measurements, population, sample and sampling techniques	Credit 1
2	Organization of data	Frequency distribution, moments of distribution	
3	Matrices	Matrix Algebra : Types and Properties of Matrices, Addition, Subtraction, Multiplication, Inverse	
4	Correlation & Regression	Correlation: Concepts and methods Regression: Bi-variate, Linear, Exponential and Power Multivariate , Principle Component Analysis	Credit 1
5	Probability	Normal, Binomial, Poison Introduction to Boolean and Fuzzy Logic	Credit 1
6	Geostatistics	Pattern analysis, measures of arrangement & dispersion, Autocorrelation, semivariogram, Kriging	

Reference Books:

1] Quantitative Techniques in Geography by Hammond, R.and McCullagh, P. Clarendon, Oxford, 1991.
2] Statistical Methods for Geographers by Gregory, S., Longman, 1978.
3] Statistics: Concepts and Applications by Frank, H. and Althoen, S.C., Cambridge University Press, 1994..
4] Statistics in Geography by Ebdon, D., Basil Blackwell, 1977.

Course GE 204
Practical in Digital Image Processing: 5 credits

1	Familiarization with image processing system	Loading of image data, identification of objects on visual display, study of histograms & layer information	Credit 1
2	Image enhancement techniques	Linear & non-linear contrast enhancement, band ratioing, edge enhancement, High pass & Low pass filtering, density slicing	Credit 1
3	Image registration	Registration of bases map/topomap, image to map, image to image	Credit 1
4	Image classification techniques	Unsupervised supervised: Maximum Likelihood, Mahalonobis distance, Minimum Distance to Mean	Credit 1

5	Accuracy analysis	Producer, User accuracy, overall & mapping accuracy, Kappa Coefiicient	
6	Vector Layers	Generation of Vector Layer, editing & topology building, Area & Perimeter Estimation	Credit 1
7	Presentation	Map Composition	

Reference Books:

1] ERDAS IMAGINE Field guides Printed by United States of America.
2] ERDAS IMAGINE Tour guides Printed by United States of America.

Course GE 205
Practical in Spatial Analysis: 6 credits

1	**Overview of ArcGIS**	**A**rc Map, Arc Catalog**,** Arc Toolbox, Help etc	Credit 1
2	**Geodatabase in Arc catalog**	Feature dataset, feature classes, import of data, spatial data formats, Shape/coverage files and layers, data frames, maps, managing TOC, displaying qualitative/ quantitative values, labeling features.	
	Working with layers	Building templates, classification, map creation,	
3	**Georeferenced data**	coordinate systems, datum conversions, Map projections, types, storing-viewing projection information.	Credit 1
	Editing data	Selecting features, simple editing functions, creating new features, modifying, schema changes	
4	**Spatial and aspatial data**	Spatial: Linking features & attributes. geodatabase data format, ways to view data, metadata etc. Aspatial: Understanding tables, field types, table manipulations, table relationships, joins and relates, creation of graphs and reports	Credit 1
5	**Spatial analysis**	Query: Identifying, measuring, query by location/attribute Spatial Analysis: Geoprocessing wizard, spatial analysis functions Multi-criteria analysis using Boolean logic	Credit 1
6	**Network analysis**	Network utility, creating network model, shortest path	Credit 1
7	**Presenting data**	Map design and map composition	
8	**Project work**		Credit 1

Reference Books:

1] The ESRI guide to GIS analysis by Andy Mitchell 1999.
2] The ESRI guide to Geodatabase design by Michael Zeiler 1999.
3] GIS Education Solutions from ESRI, Introduction to ArcGIS- **I**, Course Lectures, 2003 Published by ESRI.
4] ArcGIS 9, Building A Geodatabase by Andrew Perencsik, Simon Woo, Bob Booth, Scott Crosier, Jill Clark, Andy MacDonald, 1999-2004, USA.
5] ArcGIS 9, Geodatabase Workbook by Bob Booth, Jeff Shaner, Andy MacDonald, Phil Sanchez, Rhonda Pfaff, 2004, USA.
6] ArcGIS 9 , Using ArcMap by Melanie Harlow, Rhonda Pfaff, Michael Minami, Alan Hatakeyama, Andy Mitchell et al 2000-2004, USA.

7] ArcGIS 9, Editing in ArcMap by Rhonda Pfaff, Bob Booth, Jeff Shaner, Scott Crosier, Phil Sanchez, Andy MacDonald, 2000-2004, USA.
8] ArcGIS 9, Using ArcCatalog by Aleta Vienneau, Jonathan Bailey, Melanie Harlow, John Banning, Simon Woo, 2003-2004, USA.

Course GE 301
Advances in RS and GIS: Theory - 5 Credits

1	**Advance techniques of digital image processing**	Principal Component Analysis, Fourier transformation, IHS, Texture, Sub-pixel, Hyper-spectral & Image fusion	Credit 1
2	**Thermal Imaging System**	Concept, IR region of the EMR, Atmospheric transmission, Thermal properties of materials, Characteristics & Advantages of IR images	
3	**Digital Photogrammetry**	Concept & techniques, Application of Cartosat 1 data	
4	**Microwave Remote Sensing**	Concept, Sensors, Radar Operating Principles, Synthetic Aperture Radar, Radar Image Characteristics	Credit 1
5	**Spatial decision analysis Fuzzy Logic**	Multi-criteria decision analysis, estimation of weights, Fuzzy logic, operations on fuzzy set. Fuzzy vs. Boolean, Basic rules for inference, Artificial Neural Network	Credit 1
6	**Recent trends in GIS**	basic concepts, Conventional vs data base modeling with OOGIS, History of network technology, network architecture, Internet GIS, its components, implementation and benefits Inter-operability specifications	
6	**Spatial data Mining Customization of geoinformation**	Methods for knowledge discovery in spatial databases, methods of clustering, exploring spatial association, mining in image and raster databases. Process of customization, cost of customization, uses and advantages of customization, National Spatial Database Infrastructure, Open Geospatial Consortium	Credit 1
7	**Decision support systems**	Types of problems, efficiency and effectiveness of decision making, architecture of DSS, tools, significance of DSS, DSS and Expert Systems.	Credit 1

Reference Books:

1] Remote Sensing Digital Image Processing by Richards J. A, Xiuping Jia, Published by Springer Verbg Berline Heidelberg My. 1999
2] Digital Image Processing and Analysis by Chanda B., Dattaa D , Majumdar , Published by Prentice- Hall of India , Feb 2001
3] Digital Remote Sensing by Prithvish Nag and M. Kudrat , Concept Publishing Company, New Delhi- 110059, 1998
4] Lecture notes module **II**, Image Analysis and Interpretation, IIRS
5] Geographical Information Science, Vol. I by Roy P. S., Published by IIRS, 2000.
6] Fundamentals of Geographic Information Systems, Second Edition by Demers M.N., Published by John Wiley & Sons, 2000.
7] Principles of Geographical Information Systems by Burrough P. A. MacDonneli R. A., Published by Oxford University Press, 2000.
8] GIS and Multi-criteria Analysis by Makrewski Jacek, USA, 1999

Course GE 302
Application of RS and GIS (Part I): Theory - 5 credits

1	**Geosciences**	Concepts in Geomorphology, landform analysis- Aerial/satellite data interpretation, drainage basin morphometry and slope mapping, Integrated approach for landslide hazard zonation mapping	Credit 1
2	**Water Resources**	Watershed Hydrology and Physical processes in watershed, Principles of RS in Water Resource assessment, River Valley Project Planning, Organization and design of spatial and non spatial data in water resource in engineering	Credit 1
3	**Agriculture and Soil**	Spectral Characteristics of Crop, Crop inventory, Crop yield modeling, Physiographic soil mapping. Crop water management, Agro ecological zoning and land evaluation	Credit 1
4	**Case studies**	Review of case studies in Geosciences, Water Agriculture and Soil	Credit 2

Reference Books:

1] Application of RS and GIS in Geosciences, Lectures notes by CSSTEAP, IIRS.
2] Application of RS and GIS in Water Resources, Lectures notes by CSSTEAP, IIRS.
3] Application of RS and GIS in Agriculture and Soil, Lectures notes by CSSTEAP, IIRS.
4] Remote Sensing for sustainable Development, Proceedings of National Symposium organized by ISRS and RSAC, Nov 1992, Published by ISRS.
5] Proceeding of National Symposium on RS for Agricultural Application held at New Delhi, Dec 1990, ISRS/IARI.
6] Proceedings of ISPRS Commission VII Symposium Resource and Environmental Monitoring ,Hyderabad, Dec2002.
7] Pre-Symposium Tutorial on Sustainable Agriculture (Volume of Lectures), Dec 2002, NRSA
8] National Agricultural Drought Assessment and Monitoring System, India, Summary Report, Sept 2001
9] ISPRS Technical Commission VII Symposium on Resource and Environmental Monitoring and ISRS Annual Convention- ABSTRACTS, Dec 2002, NRSA.

Course GE 303
Application of RS and GIS (Part II): Theory - 5 credits

1	**Forest**	DIP for Forest / vegetation classification and mapping, Forest inventory and sampling techniques, Growing stock estimation, Biomass estimation, Forest management, Fire risk zonation, Land evaluation for forestry, Landscape Analysis, Wildlife Habitat Suitability Analysis, Remote sensing of forest ecosystem	Credit 1
2	**Marine Sciences**	Fundamentals of Marine Ecology, Bio Resource mapping and monitoring, Coastal Bathymetry, Ocean Color mapping, SST mapping, Potential Fishing zone mapping,	Credit 1
3	**Urban Mapping**	Large scale (LIS) mapping for cadastral database, traffic and parking surveys, Urban land use classification monitoring and change detection analysis, Utility planning, Integrated development planning, Urban land conservation, transportation planning	Credit 1

4	**Disaster Management**	Natural and Manmade, Types, zoning, preparedness	Credit 1
5	**Case studies**	Review of case studies in forest, marine, urban & disaster management	Credit 1

Reference Books:

1] Remote Sensing and GIS Application in Urban and Regional studies by Subudhi A P, Sokhi B S, Roy P S, IIRS,2001
2] Natural Disaster and their Mitigation by PS Roy, Published by IIRS, 2000
3] Biodiversity Characteristics at Landscape Level in North East using satellite Remote And Geographical Information System by Roy P S., IIRs, 2002
4] Forest Cover Assessment in Asia by P.S. Roy, IIRS, 2002
5] Biodiversity and Environment by P.S. Roy, IIRS, 2000
6] Subtle Issues in Coastal Management by Sudershana R, Mitra D, Mishra , Roy P.S., Rao D.P., IIRS, 2000
7] Spatial Technologies for Natural Hazards Management (Proceedings of ISRS National Symposium Nov 21-22,2000, IIT Kanpur)
8] Application of RS and GIS in Disaster Management, Lectures notes by CSSTEAP, IIRS.
9] Forest Resource Management, Lectures notes by CSSTEAP, IIRS.
10] Application of RS and GIS in Marine Sciences, Lectures notes by CSSTEAP, IIRS.
11] Application of RS and GIS in Urban Mapping, Lectures notes by CSSTEAP, IIRS.
12] Description and use of Landuse/ Landcover by Deekshatulu B. L., NRSA, 1990.

Course GE 304
Practical in Advanced RS and GIS: 5 Credits

1	Advanced image enhancement techniques	Principal Component Analysis Fourier transformation, IHS, Texture	Credit 1
2	Interpretation of images	Visual interpretation of Thermal & Radar images	Credit 1
3	Ground radiometry	Principle and working of Ground Radiometer, data collection, data integration & analysis	Credit 1
4	Advanced spatial analysis	Multi-criteria analysis in Arc GIS using Fuzzy logic	Credit 1
5	Customization	Customizing Arc GIS Interface, Use of VB for application	
6	Application	Case Studies	Credit 1

Reference Books:

1] GIS Education Solutions from ESRI, Introduction to ArcGIS- **II**, Course Lectures, 2003 Published by ESRI.
2] ArcGIS 9, Using 3D Analyst by Steve Bratt, Bob Booth, 2002-2004, by USA
3] ArcGIS 9, Using ArcGIS Spatial Analyst by Jill McCoy, Kevin Johnston, Steve Kopp, Brett Borup, Jason Willison, Burce Payne, 2001-2002, USA
4] ArcGIS 9 , Using ArcGIS Spatial Analyst by Tim Hodson and Kristin Clark, 2002-2003, USA

Course GE 305
Practical in Programming and Customization: 5 Credits

A			
1	**Introduction**	Concepts, Logic development, History of programming languages. Procedural & object oriented languages., designing software projects- top down, bottom up implementation, Compilers, Interpreters, Editors, Debuggers	Credit 1
2	**C language** **Input/Output functions in C** **Data types Operators**	Features, structure, keywords, statements, blocks, functions Console input/output, formatted input output, Reading /displaying single/ string of characters. Constants, variables, local/global/parametric variables, scope, lifetime of variables. Arithmetic, logical, relational, bitwise	
3	**Control constructs** **Arrays & strings** **Pointers**	Conditional, multiple branching, loop, jump constructs Single-multidimensional arrays, array initialization, string manipulation functions Meaning of pointer variable, use of pointer to access memory, pointer arithmetic, pointers & strings.	
4	**Structures & Unions** **File input/output** **Library Functions & Graphics**	Syntax of structure, elements and arrays of structures, unions, user defined data types File structure-Ascii/binary, reading from & writing into files. Maths, graphics, I/O functions, Graphics with Turbo C, display resolution, graphics initialization, drawing Line graphs, drawing different shapes- rectangle, circle, Drawing Graphics text.	Credit 1
B			
1	**Object oriented languages**	Object oriented programming paradigm. Basic concepts of objects/classes, benefits of object oriented design	
2	**Simple C++ program** **Operators** **Functions**	Structure of C++ program. Creating & compiling source files, example of class, basic data types, keywords, user defined data types, declaration of variables. Scope, resolution operator, memory management operators, operator precedence, operator overloading Function prototyping, call by reference, inline functions, default arguments, function overloading, friend & virtual functions	Credit 2

3	**Classes & objects** **Constructors & destructors**	Specifying a class, defining member function, private, public members. Memory allocation of objects, static data members/functions. Objects as function arguments, arrays of objects. multiple constructors in a class, constructors with default arguments. Copy & dynamic constructors. Destructors in a class	
4	**Inheritance**	Defining derived classes, single, multilevel, multiple, hybrid, Hierarchical inheritance, Virtual base classes, Virtual functions & polymorphism abstract classes, pointers to objects, pointers to derived Classes, pure virtual functions	
5	**Managing input/output & working with files**	C++ stream classes, formatted unformatted I/O, manipulators, classes for file streams, file pointers & their manipulations. Reading/writing sequential & random access files	
6	**templates & exception handling**	Class, function templates, template argument, exception handling, error codes.	
7	**Customization**	Concept, Exercises and Project Work	Credit 1

Reference Books:

1] C Programming Language, (ansi C Version) by Kernighan and Ritchie, Prentice Hall PTR date, 1998

2] Object Oriented Programming with C++. by Balaguruswamy, Tata McGraw Hill Publishing Co.Ltd. New Delhi., 1998

3] Programming in ANSI C, by Balaguruswamy, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2002.

4] Let us C++, by Yaswant Kanetkar, BPB Publications, 2000.

5] Let us C , by Yaswant Kanetkar, BPB Publications, 2001.

Semester IV Course GE 401
Project Work: 25 credits

1	Problem identification and literature review	Credits 4
2	Data acquisition / collection	
3	Field work	Credits 4
4	Data processing	Credits 5
5	Results and interpretation	Credits 5
6	Report writing	Credits 5
7	Presentation	Credits 2

Semester I Course GR 101
Concepts in Geography: Theory 3 credits

1	**Introduction**	Geography as a discipline: Nature and Scope	Credit 1
2	**Natural resources**	Nature and distribution of Biotic and Abiotic resources	
3	**Human resources**	Quantitative and qualitative	Credit 2
4	**Sustainable development**	Resources and development with special reference to India	

Reference Books:

1] Elements of Cartography, Sixth Edition by Robinson A. H. Morrison J. L., Muehacke P.C., Published By John Wiley & sons, 1995.
2] A Complete Course of Certificate Geography, Part I by Nigam V. N., Published by pitambat Publication Comp., 1983
3] Geographical Interpretation of Indian Topographical Maps by Tamaskar B. G., Deshmukh V. M., Orient Longman Ltd, 1974
4] John R. Weeks (1999) : Population- An Introduction to Concepts and Issues, Wadsworth Pub. Co. Ca USA.
5] Knowled R. and Wareing J. (1998): 'Economic and Social Geography', Rupa and Co., N. Delhi
6] Sundaram, K. P. and Dutta, Rudra (2001), Indian Economy.
7] Population Reference Bureau:' World Population data Sheet, 2000', Washington DC.
8] Hudson, R. S. (1970):'A Geography of Settlements', McDonald and Sons, London.
9] Chisholm, M. (1962):' Rural Settlements and Landuse' London.
10] Short, John R. (1984) : ' An Introduction to Urban Geography', Routledge and Regan Paul, London.