SAVITRIBAI PHULE PUNE UNIVERSITY
DEPARTMENT OF GEOGRAPHY

Credit System (M.Sc. Geoinformatics): Details of the Courses and Credits – 2020

SEMESTER I				
Core Courses				
Subject Code	**Subject Title**	**Credits Per Subject**	**Credits To Be Completed**	
			Subject-Wise	**Semester-Wise**
GE 101	Fundamentals of Remote Sensing	3	3	
GE 102	Fundamentals of GIS and GPS	3	3	
GE 103	Practical in Spatial Data Processing	3	3	
GE 104	Basics of Photogrammetry	2	2	
GE 105	Applied statistics and computing	3	3	
GE 106	Database Management Systems: Concepts and Methods	3	3	
GE109	Concepts in Geography (Non-credit course)			
Elective Courses				
	Any one of the following courses			
GE 107	Introduction to basic programming	3	3	
GE 108	Cartography and Data representation	3	3	
	Total credits in semester I	**20**	**20**	**20**
SEMESTER II				
Core Courses				
Subject Code	**Subject Title**	**Credits Per Subject**	**Credits To Be Completed**	
			Subject-Wise	**Semester-Wise**
GE 201	Digital Image Processing: Theory	2	2	
GE 202	Geospatial analysis: Theory	3	3	
GE 203	Digital Image Processing: Practical	3	3	
GE 204	Practical in Geospatial analysis	3	3	
GE 205	Advance Surveying and field work	3	3	
GE 206	Open source GIS	3	3	
Elective Courses				
	Any one of the following courses			
GE 207	Application in Natural resource management	3	3	
GE 208	Introduction to Python	3	3	
	Total credits in semester II	**20**	**20**	**20**
***Summer Internship* (2 months)**				

SEMESTER III				
Core Courses				
Subject Code	**Subject Title**	**Credits Per Subject**	**Credits To Be Completed**	
			Subject-Wise	**Semester-Wise**
GE 301	Advances in Remote Sensing	3	3	
GE 302	Advances in GIS	3	3	
GE 303	Practical in Advance Geospatial analysis	3	3	
GE 304	Web and Mobile GIS	3	3	
GE 305	Research Methodology and Project Management	2	2	
Elective Courses				
	Any two of the following courses			
GE 306	Programming in .NET	3	3	
GE 307	Application in Hydrology and Agriculture	3	3	
GE 308	Java Scripting	3	3	
GE 309	Applications in Atmosphere, Health and Energy	3	3	
	Total credits in semester III	**20**	**20**	**20**
SEMESTER IV				
GE 401	Project Work	20	20	
	Total credits in semester IV	**20**	**20**	**20**

Semester I

Code: GE 101 Fundamentals of Remote Sensing		
No.of Credits: 03		**No. of Lectures: 45**
Sr. No.	**Topic**	**Lectures**
1	Introduction to Remote Sensing: Concepts Definition, History Development, Stages in RS-EMR, EMR Spectrum, Theories of EMR, Types of RS and Laws of Radiation,Introduction to solar spectrum.	9
2	Interaction of EMR: Interaction with Earth's Atmosphere, Atmospheric Window	6
3	Fundamentals of Radiometry: concept of solid angle, radiometric measurements, observation geometry in RS	8
4	Spectral Signature: Interaction with Soil, Water and Vegetation	6
5	Platforms, Sensors, Orbits: Types of Platform, Types of Sensors, Cameras and Satellite Orbits	8
6	Data Products: Satellite Data Generation, Type of data Formats and Aerial Photography Products, FCC & TCC images and its applications	8

Books:

1. Joseph, G. (2004). *Fundamentals of Remote Sensing*. Universities Press.
2. Lillesand, T. M., Kiefer, R. W. & Chipman, J. W. (2008). *Remote Sensing and Image Interpretation*. John Wiley & Sons.
3. Sabins, F. F. (1996). *Remote Sensing: Principles and Interpretation*. San Francisco: W.H. Freeman and Company.
4. Jensen, J. R. (2005). *Introductory Digital Image Processing*. New Jersey: Prentice Hall.
5. Drury, S. A. (2001). *Image Interpretation in Geology*. Oxford: Blackwell.
6. Campbell, J. (2002). *Introduction to Remote Sensing*. London: Taylor & Francis.
7. Anji Reddy, M. (2008). *Textbook of Remote Sensing and Geographic Information System*. Hyderabad: B.S. Publication.

Code: GE 102	**Fundamentals of GIS and GPS**	
No. of Credits: 03		**No. of Lectures: 45**
Sr. No.	**Topic**	**Lectures**
1	Introduction to GIS: Definitions, Evolution, Components and Objectives	3
2	Overview of GIS Software Packages	5
3	Spatial Data: Types of Geographic Data, Levels of Measurements. Concepts of Space and Time, Layers Coverage. Spatial Data Models, Representation of Geographic Features in Vector, Raster Data Models. Concept of Arc, Node, Vertices and Topology. Object Oriented Models: Advantages and Disadvantages. Computer Representation for Storing Spatial Data: Block Code, Run-Length Encoding, Chain Coding, Quadtree. Issues Governing Choice of Models.	12
4	Non-Spatial Data: Advantages of Data Base Management System. Conceptual Implementation Models, Hierarchical, Network, Relational Models. RDBMS: Components, Concept, Database Schema, Tables and Relationships. Database Design Normalization (1NF, 2NF, 3NF Forms) Data Definition Manipulation using SQL, SQL-Query Processing, Operations on Tables, Integrity Constraints, Database Security,Role of Database Administrator (DBA). Metadata	12
5	Spatial Data Input: Digitization, Error Identification. Errors: Types, Sources, Correction.Editing and Topology Building	5
6	Concepts of GPS: Spherical trigonometry, History, Types, Navigation Systems and Applications, Introduction to IRNSS.	8

Books:

1. Longley, P. A., Goodchild, M. F., Maguire, D. J., Rhind, D. W. (2002). *Geographical Information Systems and Science*. Chichester: John Wiley & Sons.
2. Lo, C. P., Yeung, A. W. (2002). *Concepts Techniques of Geographical Information Systems*. New Delhi: Prentice-Hall of India.
3. Chang, K. T. (2008). *Introduction to Geographic Information Systems*. Avenue of the Americas, New York: McGraw-Hill.
4. Korte, G. B. (2001). *The GIS Book*, Bangalore: Onward Press.
5. Demers, M. N. (2000). *Fundamentals of Geographic Information Systems*. New Delhi: John Wiley and Sons.
6. Burrough, P. A. & McDonnell, R.A. (2000). *Principles of Geographical Information Systems*. New York: Oxford University Press.
7. Heywood, I., Cornelisus, S., Carver, S. (2011). *An Introduction to Geographical Information Systems*, New Delhi: Pearson Education.
8. Ahmed, E. L. Rabbany (2002). *Introduction to Global Positioning Systems*. Boston: Artech House.

Code: GE 103 Practical in Spatial Data Processing		
No. of Credits: 03		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Overview of Arc GIS: Arcmap, Arccatalog and Arctool Box	1
2	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 MS-Excel and MS Access	2
3	Spatial Data Input: Vector Data Formats With File Extensions. Scanning, Digitization Editing, Topology Creation, Line and Area Measurements, Data Attribution	2
4	Geodatabase in Arccatalog and Arcmap: Feature Dataset, Feature Classes, Import of Data, Spatial Data Formats, Shape/Coverage Files and Layers, Data Frames, Maps, Managing TOC	2
5	Georeferencing Data:Coordinate Systems, Datum Conversions, Map Projections, Types, Storing- Viewing Projection Information	4
6	Working with Layers in Arcmap: Building Templates, Classification, Displaying Qualitative andquantitative Values, Labeling Features and Map Creation.	1
7	Time-series data analysis	1
8	GPS: GPS Survey, Data Import, Processing and Mapping	2

Note: a) For 3 credits 3 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Books:

1. Chang, K. T. (2008). *Introduction to Geographic Information Systems*, Avenue of the Americas, New York: McGraw-Hill.
2. Environmental Systems Research Institute, Inc. (1998): Understanding GIS: The ARC/INFO Method, ESRI Press, Redland
3. Ahmed, E. L., Rabbany (2002). *Introduction to Global Positioning System*. Boston: Artech House.
4. Kresse, W. & Danko, D. (2002). *Springer Handbook of Geographic Information*. London: Springer Drecht.
5. Bao, J., Tsui, Y. (2005). *Fundamentals of Global Positioning System Receivers*, Hoboken: John Wiley Sons, Inc.

Code: GE 104	**Basics of Photogrammetry**	
No. of Credits: 02		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Aerial Photography: Introduction to Aerial Photography and Basic Photogrammetry	3
2	Measurements: Geometry of Aerial Photographs, Determination of Scale, Parallax and height measurement	2
3	Aerial Photo and Image Interpretation: Interpretation of Aerial Photos: Single, Vertical Stereo Pairs. Interpretation of Satellite Imagery: Derived From PAN, LISS, Wifs, OCM Sensors. Study and Visual Interpretation of Satellite Images for Physical Features, Urban, Forest and Agricultural Uses	3
4	DigitalPhotogrammetry: Concept and Techniques, Data Generation and Research Application of Cartosat-1 Data Lidar-altimeter	3
5	Field Work/Study Tour: Identification of Features in the Field Using Aerial Photographs and/or Satellite Images	4

Note: a) For 2 credits 2 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Books:

1. Lillesand, T. M., Kiefer, R.W., & Chipman, J. W. (2008). *Remote Sensing and Image Interpretation*. New Delhi: John Wiley & Sons.
2. Joseph, G. (2004). *Fundamentals of Remote Sensing*. Hyderabad: Universities Press.
3. Agarwal, C. S., Garg, P. K. (2000). *Remote Sensing*. New Delhi: Wheeler A. H.
4. Drury, S. A. (2001): Image Interpretation in Geology, Blackwell, Oxford
5. Wolf, P.R. (1974). *Elements of Photogrammetry*, Kogaknscha: McGraw Hill Inc.

Code: GE 105	**Applied statistics and computing**	
No. of Credits: 03		**No. of Practical:15**
Sr. No.	**Topic**	**Practical**
1	Geographic Data: Sources, Types, Discrete and Continuous Series, Scales of Measurements, Population, Sample and Sampling Techniques.	3
2	Organization of Data: Frequency Distribution, Moments of Distribution, Measures of Central Tendency, Dispersion and Kurtosis.	3
3	Matrices: Matrix Algebra: Types and Properties of Matrices. Addition, Subtraction, Multiplication and Inverse.	3
4	Correlation and Regression: Correlation: Concepts and Methods Regression: Bi-Variate, Linear, Exponential, Logarithmic, Power-Law.	3
5	Principal component analysis (PCA) and Trend Surface Analysis (TSA)	1
6	Introduction to R	2

Books:

1. Hammond, R. & McCullagh, P. (1991). *Quantitative Techniques in Geography*, Oxford: Clarendon Press.
2. Gregory, S. (1978). *Statistical Methods for Geographers*. London: Longman.
3. Frank, H. & Althoen, S.C. (1994). *Statistics: Concepts Applications*, Cambridge: Cambridge University Press.
4. Ebdon, D. (1977). *Statistics in Geography*. Oxford: Basil Blackwell.
5. Rogerson, P.A. (2010). *Statistical Methods for Geography*. London: Sage Publications.

Code: GE 106 Database Management Systems: Concept and Methods		
No. of Credits: 03		**No. of Practical: 15**
Sr.No.	**Topic**	**Practical**
1	Introduction: DBMS, RDBMS, SQL Database Security Concept and Advantages of RDBMSand ER Modeling.	2
2	Controlling User Access: Control Database Access, Privileges, Creating User, Concept of Role, Creating, Granting Privileges to Role, Revoking Privileges. Changing Password	2
3	Managing Schema Object: Data Types, DDL, DML, DCL Constraints: Types of Constraints, Primary Key, Foreign Key, Check Constraint, Not Null, Altering Constraint, Concept of Backup Recovery. Overview of Index.	2
4	Manipulating Dataset using SQL Statement: Basic Select Statement, Selecting Specific Column, Using Arithmetic Expressions, Defining Column Alias, using Where Clause	2
5	Restricting & Sorting Data: using Comparison Condition (=,<=,>=Etc), Using Logical Operator: AND, OR, NOT, using BETWEEN, LIKE Conditions Rule of Precedence,using Order by Clause	2
5	SQL Function: Displaying Data From Multiple Tables, Sub-Query, Concept ofFunction, Types, Group Functions, Use of Group by, Having Clause. Types of Joins, Concept of Sub-Query, Types of Sub Queries.	2
6	Pl/Sql:Introduction to Pl/Sql, Variables and Types Declaration in Pl/Sql. Simple Program in Pl/Sql: Assignment Operator, Output Statement, Accepting Input from User.Simple Program in Pl/Sql Using Table: Syntax of Using 'Select' Statement in Pl/Sql, 'If' Statement and Loops in Pl/Sql. Creating Procedure, Function, Cursor, Trigger, Packages.	3

Books:

1. Deshpande, P. S. (2008). *SQL & PL/SQL for Oracle 10g*. Blackbook. New Delhi: Dreamtech Press.
2. Freeman, R. G. (2000). *Oracle DBA 7.3 to 8Upgrade*, New Delhi: Dreamtech Press.
3. http://docs.oracle.com/cd/B19306_01/server.102/b14220.pdf
4. http://www.smart-soft.co.uk/tutorial.html

http://ask2seenu.blogspot.in/2011/09/best-oracle-plsql-ebooks-download-for.html

Code: GE 107	**Introduction to basic programming**	
No. of Credits: 03		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Introduction to programming language: machine language, assembly Language, high level language, compilers and interpreters. Problem solving using computers: Algorithms and flowcharts	1
2	**C** Language: Introduction to C: History of Programming Language, Importance of Computer Languages, Understanding Compiler. Input /Output Functions: Console Input Output, Formatted Input Output.	2
3	Data Types and Operators: Control Structures: Types of Loops. Introduction to Array: Single Multidimensional Array.	2
4	Introduction to Functions, File Handling: Reading and Writing the Data to File	2
5	Introduction to basic C ++	1
6	Introduction to OOP Classes and Objects: Importance of OOP Understanding Classes, objects, Methods and properties.	3
7	OOP and POP: Difference between OOP and POP Constructors and Destructors: Creating classes and objects.	3
8	Overview of C#/Python/R/Matlab and HTML	1

Note: a) For 3 credits 3 hours practical per week.
b) The concerned teacher may add some points related to the subject

Books:

1. Kernighan, R. (1998). *C Programming Language*. (ANSI C Version). New Jersey: Prentice Hall.
2. Balagurusamy, E. (2002). *Programming in ANSI C*, New Delhi: Tata McGraw Hill.
3. Kanetkar, Y. (2001). *Let Us C*. New Delhi: BPB Publications.
4. Bjarne Stroustrup (2015). *The C# Programming Language*. 4th edition.
5. Malik, D. S. (2009). *C# Programming Language*. Cengage Learning.

Code: GE 108	**Cartography and Data Representation**	
No. of Credits: 03		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Introduction to Cartography and Elements of Map design	3
2	Datum and Map Projection and Coordinate system : Concepts, types and Uses	3
3	Map types: Reference, Thematic, Topographical, Cadastral	2
4	Data and Data Types: Nominal, Ordinal, Interval, Ratio Graphical Representation of Statistical Data: Maps, Unimodal, Two-Dimensional and Three dimensional diagrams.	3
5	Interpretation of SOI Topographical Maps, Identification and Visualization of Different Physical and Manmade Features	3
6	Digital Cartography and Digital Data Representation	1

Books:

1. Singh, R. L. (1979). *Elements of Practical Geography*, New Delhi: Kalyani Publishers.
2. Croxton, F. E., Cowden, D. J., Klein, S. (1975). *Applied General Statistics*, New Delhi: Prentice-Hall of India.
3. Frank, H. Althoen, S. C. (1994). *Statistics Concepts and Applications*. Cambridge University Press.
4. Yeates, M. (1974). *An Introduction to Quantitative Analysis in Human Geography*, New York: McGraw-Hill.

Code: GE 109	**Concepts of Geography**	
No. of Credits: Non- credits course		**No. of Lectures: 10**
Sr. No.	**Topics**	**Lectures**
1	Introduction: Geography as a Discipline.	2
2	Concepts: Place (physical and cultural attributes), Space, Environment interconnection, Sustainability, Location (Relative / Absolute), Region, Spatial Interaction.	2
3	Approaches: Systematic, Regional, Environmentalism and Possibilism.	2
4	Definition, Concepts, Nature and Scope of Physical Geography (Geomorphology and Climatology).	2
5	Definition, Concepts, Nature and Scope of Human Geography (Economic, Population and Settlement).	2

Books:

1. Robinson A. H., Morrison J. L., Muehacke P.C., (1995). *Elements of Cartography.* John Wiley & sons.
2. Nigam V. N., (1983). *A Complete Course of Certificate Geography, Part I*. Pitambat Publication Comp.
3. Tamaskar B. G., Deshmukh,V. M., (1974). *Geographical Interpretation of Indian Topographical Maps.* Orient Longman Ltd.
4. John, R., Weeks (1999). *Population- An Introduction to Concepts and Issues*, Wadsworth Pub.Co. Ca USA.
5. Knowled, R., & Wareing, J. (1998). *Economic and Social Geography*. N. Delhi: Rupa and Co.,
6. Sundaram, K. P. & 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*. London.: McDonald and Sons.
9. Chisholm, M. (1962). *Rural Settlements and Landuse*. London.
10. Short, John R. (1984). *An Introduction to Urban Geography*. London: Routledge and Regan Paul.

Semester II

Code: GE 201	**Digital Image Processing: Theory**	
No. of Credits: 02		**No. of Lectures: 30**
Sr. No.	**Topic**	**Lectures**
1	Introduction to Digital Image Processing: Digital Images: Types Sources of Errors: Atmospheric, Radiometric and Geometric. Image Rectification: Geometric Correction, Radiometric Correction, Noise Removal	10
2	Image Enhancement Techniques: Contrast Enhancement: Linear, Non-Linear, Logarithmic and Exponential, Gaussian Stretch, Density Slicing. Spatial Filtering: Low Frequency, High Frequency, Edge Enhancement, Band Rationing and Band Combination	10
3	Digital ImageClassification: Classification Scheme: Supervised Classification: Training Sites Selection and Statistical Information Extraction, Discriminate Functions. Classifier:Maximum Likelihood, Euclidian Distance, Mahalanobis Distance, Parallelepiped. Unsupervised Classification.Classification Accuracy Assessment and Error Matrix GCP and ground validation of data/image	8
4	Object oriented classification : Segmentation, Object oriented Vs pixel based classification, Algorithms for classification	2

Note: a) For 2 credits 2 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Books:

1. Richards, J. A, Jia, X. (1999). *Remote Sensing and Digital Image Processing*. Verlag Berlin: Springer.
2. Cha, B., Dattaa, D., Majumdar (2001). *Digital Image Processing Analysis*. New Delhi: Prentice-Hall of India.
3. Nag, P. Kudrat, M. (1998). *Digital Remote Sensing*. New Delhi: Concept Publishing Company.
4. Jensen, J. R. (2005). *Introductory Digital Image Processing*. New Jersey: Prentice Hall.
5. Lillesand, T. M., Kiefer, R. W. Chipman, J. W. (2008). *Remote Sensing and Image Interpretation*, New Delhi: John Wiley & Sons.
6. Sabins, F. F. (1996). *Remote Sensing: Principles an Interpretation*, New York: W. H. Freeman Company.

Code: GE 202	**Geospatial analysis: Theory**	
No. of Credits:03		**No. of Lectures: 45**
Sr. No.	**Topic**	**Lectures**
1	Introduction to Spatial Analysis: Significance of Spatial Analysis. Overview of Tools for Analysis	2
2	Spatial Analysis – Vector Based: Overlay Operations: Point-in-Polygon, Line-in-Polygon, Polygon-in-Polygon. Single Layer Operations: Feature Identification, Extraction, Classification Manipulation. Multilayer Operation: Union, Intersection, Symmetrical Difference, Update, Merge, Append and Dissolve	5
3	Spatial Analysis – Raster Based: Map Algebra, Grid Based Operations, Local, Focal, Zonal and Global Functions, Cost Surface Analysis, Optimal Path and Proximity Search	5
4	Network Analysis: Concepts, Evaluation of Network Complexity Using Alpha-Gamma Indices. C-Matrices for Evaluating Connectivity of the Network. Network Data Model. Path Analysis. Linear Referencing and Segmentation. Types of Network Analysis: Optimum Cyclic Path, Vehicle Routing, Path Determination and Cost-Path Analysis. Geocoding	8
5	Point Pattern Analysis: Methods for Evaluating Point Patterns: Clustered and Random Distribution	5
6	Surface Analysis: Interpolation Methods: Trend Surface Analysis, IDW, Kriging, Measures of Arrangement and Dispersion, Autocorrelation, Semi-Variogram, DEM, TIN, Slope, Aspect, Hill Shadeandview Shed	10
7	Spatial Modeling: Role of Spatial Model, Explanative, Predictive and Normative Models. Correlation-Regression Analysis in Model Building. Handling Complex Spatial Queryandcase Studies	8
8	Introduction to Spatial Analysis using ‘R’	2

Books:

1. Demers, M. N.(2000). *Fundamentals of Geographic Information Systems*. New Delhi: John Wiley and Sons.
2. Burrough, P. A. & McDonnell, R.A. (2000). *Principles of Geographical Information Systems*. New York: Oxford University Press.
3. Makrewski, J. (1999). *GIS Multi-criteria Analysis*, New York: John Wiley and Sons.
4. Chang, K. T. (2008). *Introduction to Geographic Information Systems*, Avenue of the Americas, New York: McGraw-Hill.
5. Longley, P. A., Goodchild, M. F., Maguire, D. J. Rhind, D. W. (2002). *Geographical Information Systems and Science*. Chichester: John Wiley & Sons.
6. Lo, C. P., Yeung, A. W. (2002). *Concepts Techniques of Geographical Information Systems*, New Delhi: Prentice-Hall of India.

Code: GE 203 Practical in Digital Image Processing		
No. of Credits:03		**No. of Practical:15**
Sr. No.	**Topic**	**Practical**
1	Introduction to ERDAS	2
2	Familiarization with Image Processing System:Loading of Image Data, Identification of Objects on Visual Display, Study of Histograms and Layer Information	2
3	Image Enhancement Techniques: Linear and Non- Linear Contrast Enhancement, Band Rationing, Edge Enhancement, High and Low Pass Filtering, Density Slicing	2
4	Image Registration: Registration of Bases Map/ Topomap, Image to Map, Image to Image	1
5	Image Classification: Classification : Supervised, Unsupervised and Use of Different Algorithms, Change Detection	3
6	Accuracy Analysis: Producer, User Accuracy, Overall and Mapping Accuracy, Kappa Coefficient	2
7	Vector Layers: Generation of Vector Layer, Editing and Topology Building, Area and Perimeter Estimation Presentation: Map Composition	2
8	Presentation : Map composition	1

Note: a) For 3 credits 3 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Books:

1. ERDAS (2010). *ERDAS field Guide*, ERDAS incorporation, Norcross, GA, USA
2. http://geospatial.intergraph.com/Libraries/Tech_Docs/Erdas_Field_Guide.sflb.ashx
3. Gupta, R. P. (2003). *Remote Sensing Geology*. Verlag Berlin: Springer.

Code: GE 204	**Practical in Geospatial Analysis**	
No. of Credits:03		**No. of Practical:15**
Sr. No.	**Topic**	**Practical**
1	Editing Data: Selecting Features, Simple Editing Functions, Creating New Features, Modifying, Schema Changes	2
2	Spatial And Non-Spatial Data: Spatial: Linking Features Attributes, Ways to View Data, Metadata Non-Spatial : Understanding Tables, Field Types, Table Manipulations, Table Relationship, Joins, Relates, Creation of Graphs and Reports	2
3	Spatial Analysis: Query By Attribute and Location, Identifying Spatial and Non-Spatial Data, Geoprocessing Wizard, Spatial Analysis Functions, Multi Criteria Analysis using Boolean Logic	3
4	Network Analysis: Network Utility, Creating Network Model, Shortest Path, Geocoding	3
5	Surface Analysis: DEM, DSMand DTM	1
6	Presenting Data: Map Design, Map Composition	1
7	Spatial Data Visualization and analysis with R	1
8	Introduction to Arcpy, Arcpy Function, Arcpy Module, Arcpy Classes, Python Toolbox	2
9	Project Work	*

Note: a) For 3 credits 3 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Books:

1. Mitchell, A. (1999). *The ESRI guide to GIS analysis*. Redlands.
2. Zeiler, M. (1999). *The ESRI guide to Geodatabase design*. Redlands.
3. ESRI (2003). *Introduction to ArcGIS- I*. Course Lectures. GIS Education Solutions.
4. Booth, B., Shaner, J., MacDonald, A., Sanchez, P. Pfaff, R. (2004). *Arc GIS, Geodatabase Workbook*. Redlands.
5. Melania, H. M., Rhonda, P., Minami, M., Hatakeyama, A. M. (2004). *ArcGIS, Using ArcMap*, Redlands: ESRI Press.
6. Environmental Systems Research Institute, Inc. (1998). *Understanding GIS: The Arc/Info Method*. Redlands: ESRI Press.

Code: GE 205	**Advanced Surveying and field work**	
No. of Credits: 03		**No. of Practical:15**
Sr. No.	**Topic**	**Practical**
1	Introduction to Total Station: Principle and Function. REM, RDM, Use of Total station for data processing and analysis.	1
2	Introduction to Differential GPS (dGPS): Principle and Function. Duel and Single Frequency DGPS, RTK and Static Surveys in DGPS, Use of DGPS in Topographical Survey.	1
3	Comparison of total station with DGPS in Topographical Surveying	2
4	Introduction to Unmanned Aerial Systems (UAS), UAV(Unmanned Aerial Vehicle): Principle and Functions, Drone survey.	2
5	Total station Survey and data processing. Area selection, setup of instrument at base station and collecting points using reflector.	2
6	DGPS setting of Instruments at base and rover.	3
7	DGPS Survey and Data Processing. Generation of digital elevation model (DEM)	2

Note: a) For 3 credits 3 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Books:

1. Jeff, H. (1995). *Differential GPS Explained*. Trimble Navigation.
2. Satheesh, G., Sathikumar, R. and Madhu, N. (2007). *Advanced Surveying: Total Station, GIS and Remote Sensing.* Delhi: Pearson Education.
3. Mohinder, S. G., Lawrence, R. W. and Angus, P. A. (2001). *Global Positioning Systems, Inertial Navigation and Integration*. New York: John Wiley and Sons Inc.
4. Lawrence, L. and Alex, L. (2008). *GPS Made Easy: Using Global Positioning Systems in the Outdoors, Rocky Mountain Book*s. Calgary.
5. Stinespring, B. M. (2000). *The Experimental Evaluation of a DGPS Based Navigational System for the ARIES AUV*, Monterey, California: Naval Postgraduate School; Springfield.

Code: GE 206	**Open source GIS**	
No. of Credits: 03		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Open Source GIS: Basic Concepts, Introduction to Open Source Software	1
2	Introduction to QGIS, Interface of the software	1
3	Plugins - Installing and Managing Plugins, Useful QGIS Plugins	2
4	Working with Vector data - Generation of Vector Layers, Vector Analysis, Spatial and Attribute Queries,	3
5	Working with Raster data - Symbology, Terrain analysis, Raster Analysis	2
6	Map Composition and Representation	2
7	Online Resources - Introduction to Open Data Kit (ODK), Web Mapping Services (WMS), Web Feature Services (WFS)	3
8	Compatibility of Open Source GIS	1

Note: a) For 3 credits 3 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Books:

1. Markus Neteler & Helena Mitasova (2007). *Open Source GIS: A GRASS approach*. Springer-Verlag Berlin, Heidelberg
2. Andrew Cutts, Anita Graser (2018). Learn QGIS. https://www.packtpub.com/application-development/learn-qgis-fourth-edition

Code: GE 207 Application in Natural Resource Management		
No. of Credits: 03		**No. of practical: 15**
Sr. No.	**Topic**	**Practical**
1	Geosciences and Geology: Concepts of Geomorphology, Landform Analysis, Drainage Basin Morphometry, Slope Mapping, Integrated Approach for Landslide Hazard Zonation Models and Mapping.	3
2	Forest: Vegetation Classification Mapping, Calculation of Indices Forest Inventory, Growing Stock Estimation, Biomass Estimation, Forest Management, Fire Risk Zonation, Land Evaluation for Forestry, RS of Forest Ecosystem, Identification of Species	5
3	Disaster Management: Natural and Man-Made Disasters. Types, Zoning and Preparedness, Drought and Flood mapping using indices, Desertification.	2
4	Urban Planning and Development: Large Scale Mapping for Cadastral Database, Traffic and Parking Surveys, Urban Land Use Classification and Monitoring, Change Detection Analysis, Utility Planning, Integrated Development Planning, Urban Conservation, Transportation Planning and Land Information System, Environmental Impact Assessment (EIA)	5

Note: a) For 3 credits 3 hours practical per week.

b) The concerned teacher may add some points related to the subject.

Books:

1. SPRS Technical Commission VII (2002): Symposium on Resource Environmental Monitoring, ISRS Annual Convention, IIRS, Dehradun
2. Deekshatulu, B. L.(1990). *Description and use of Land use/Landcover*. Hyedrabad: NRSA.
3. Sudershana, R. Mitra, D. Mishra, Roy, P.S., Rao, D. P.(2000): Subtle Issues in Coastal Management, IIRS, Dehradun
4. Harris, J. E. (1990). Earth watch – The Climate from space. Ellishorwood Ltd., Midsower Norton
5. Lal, D. S. (1998). *Climatology*, Allahabad: Chaitanya Publishing House.
6. Escalante, R. B. (2012). *Remote Sensing- Advances techniques and Plateforms*, Intech, Rijeka Croatia
7. Escalante, R. B. (2012). *Remote Sensing Application*, Intech, Rijeka Croatia
8. Roy, P.S., Dwivedi, R. S. (2010). *Remote Sensing Application* www.nrsc.gov.in/Learning- Center, E Book. html

Code: GE 208	**Introduction to Python**	
No. of Credits: 03		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Introduction to Python, Python vs. .NET Vs. JAVA	1
2	Python Syntax, Basic data Types, Data Structures, Input and Output	3
3	Understanding Operators, conditional statements, looping structure, Functions.	3
4	Understanding Libraries, Data Frames and Basic operations with data frames	2
5	Reading files/datases, data manipulation and visualization	3
6	Modules and Packages, GIS data access and manipulation with python. Introduction to GDAL, Geopandas, NumPy,	4

Note: a) For 3 credits 3 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Books:

1. Lutz, M. (2010). *Programming Python: powerful object-oriented programming*. O'Reilly Media, Inc.
2. McKinney, W. (2012). *Python for data analysis: Data wrangling with Pandas, NumPy, and IPython*. O'Reilly Media, Inc.
3. Beazley, D., & Jones, B. K. (2013). *Python Cookbook: Recipes for Mastering Python 3*. O'Reilly Media, Inc.
4. https://wiki.python.org./moin/BeginnersGuide/nonprogrammers.

Semester III

Code: GE 301 Advances in Remote Sensing

No. of Credits: 03 **No. of Lectures: 45**

Sr. No.	Topic	Lectures
1	Advance Techniques of Digital ImageProcessing: Principal Component Analysis, FourierTransformation, IHS, Texture, Sub-Pixel, and Image Fusion, Image Segmentation	8
2	Thermal ImagingSystem: Concept, IR Region of the EMR, Atmospheric Transmission, Thermal Properties of Materials. Characteristics and Advantages of IR Images	8
3	Hyperspectral Remote Sensing: Concept, Multispectral Vs. Hyperspectral	10
4	Microwave,Radar Operating Principles,Synthetic Aperture Radar, INSAR and POLSAR and Radar Interferometry Radar, ImageCharacteristics.	10
5	Lidar: Concepts, Lidar Sensor System, Accuracy of Lidar Measurements, Sources of Lidar data	6
6	Recent Trends in Remote sensing EO data.	3

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Books:

1. Richards, J. A., Jia, X. (2000). *Remote Sensing and Digital Image Processing*. Verlag Berlin: Springer.
2. Chand, B., Majumdar, D. D. (2001). *Digital Image Processing Analysis.* New Delhi: Prentice- Hall of India,
3. Jensen, J. R. (2005). *Introductory Digital Image Processing*, New Jersey: Prentice Hall.
4. Lillesand, T. M., Kiefer, R. W., Chipman, J. W. (2008). *Remote Sensing and Image Interpretation*. New Delhi: John Wiley & Sons.
5. Sabins, F. F. (1996). *Remote Sensing: Principles Interpretation*, New York: W.H. Freeman Company.
6. Navalgund, R. R. Ray, S. S. (2011). *Hyperspectral Data, Analysis Techniques Application*. Dehradun: Indian Society of Remote Sensing.

Code: GE 302	**Advances in GIS**	
No. of Credits: 03		**No. of Lectures: 45**
Sr. No.	**Topic**	**Lectures**
1	Spatial Data Mining: Methods for Knowledge discovery Spatial in Databases, Methods of Clustering, Exploring, Spatial Association, Mining in Raster Database	7
2	Spatial Decision: Analysis and Fuzzy Logic Multi-Criteria Decision Analysis, Estimation of Weights. Analytic Hierarchy Process (AHP), Fuzzy Logic, Operations On Fuzzy Sets, Fuzzy Vs. Boolean, Errors and uncertainty analysis.	8
3	Basic Rules for Inference Artificial Neural Network, Introduction to Artificial Intelligence	8
4	Machine learning, Support vector machine	6
5	Decision Support Systems: Types of Problems, Efficiency Effectiveness of Decision Making, Architecture of DSS Tools, Significance of DSS, DSS Experts Systems	8
6	Recent Trend in GIS: History of Network Technology, Interoperability Specifications, Cloud Computing, Crowd Sourcing, Big data Analysis	8

Books:

1. Demers, M. N. (2000). *Fundamentals of Geographic Information Systems*, New Delhi: John Wiley& Sons.
2. Burrough, P. A. & McDonnell, R. A. (2000). *Principles of Geographical Information Systems*, New York: Oxford University Press.
3. Malczewski, J. (1999). *GIS Multi-criteria Analysis*, New York: John Wiley &Sons.
4. Williams, J. (1995). *Geographic Information from Space: Processing Applications of Geocoded Satellite Images*. New Delhi: John &Wiley Sons.

Code: GE 303 Practical in Advanced Geospatial Data Processing		
No. of Credits: 03		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Advanced Image Enhancement Techniques: Principal Component Analysis, Fourier Transformation, IHS, Texture and Image Fusion	3
2	Interpretation of Images: Visual Interpretation of Thermal, Radar and Hyperspectral Images, Processing of OCM data	3
3	Ground Radiometry: Principle Working of Ground Radiometer, Data Collection, Data Integration and Analysis	2
4	Advance Spatial Analysis: Multi-Criteria Analysis in Arcgis Using Fuzzy Logic, Classification: Fuzzy, Decision Tree	3
5	Machine Learning and AI	2
6	Application: Case Studies	2

Note: a) For 3 credits 3 hours practical per week.

b) The concerned teacher may add some points related to the subject.

Books:

1. ESRI (2003). *Introduction to ArcGIS – II*. Course Lectures. Redlands: GIS Education Solutions.
2. Bratt, S., Booth, B. (2004). *ArcGIS, Using 3D Analyst*. Redlands: ESRI Press.
3. McCoy, J., Johnston, K., Kopp, S., Borup, B., Willison, J., Payne, B. (2002). *ArcGIS, Using Arc GIS Spatial Analyst*. Redlands.
4. Hodson, T. Clark, K. (2003). *Using ArcGIS Spatial Analyst*. Redlands.
5. Environmental Systems Research Institute, InC.(1998). *Understanding GIS: The ARC/INFO Method*. Redlands: ESRI Press.

Code: GE 304 Web GIS and Mobile GIS		
No. of Credits: 03		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Web GIS: Internet GIS and distributed GIS services, Networking fundamentals of Internet GIS, Technical evolution of web mapping, commercial web mapping programs	3
2	Mobile GIS: system and generic architecture of Mobile GIS, Operating systems for Mobile GIS, Wireless web, Samples of programs used in Mobile GIS, real-time applications, customization of Mobile GIS	2
3	ArcGIS Server ArcSDE: Arcgis Server and Architecture, Web Application Functionality, GIS Web Service. ArcSDE: Introduction, SDE Connection, Configuration Options, SDEfor Developers Data Storage: SDE Geodatabase. ArcSDE Architecture	3
4	Web based databases: OpenStreet Map, Overpass turbo, Kepler.gl, Mapbox, Post GIS	4
5	Introduction to Google Earth Engine	2
6	Utility GIS: Ericson network engineering software, Arc FM, APDRP, Enterprise GIS, ArcGIS online, ArcGIS pro	1

Books:

6. Roland Billen, Elsa Joao, David Forrest (2006). Dynamic and Mobile GIS: Investigating Changes in Space and Time. CRC Press.
7. Zhong-RenPeng, Ming-Hsiang Tsou, Peng (2003). Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks. John Wiley & Sons.
8. Jonathan Raper (2008). Mobile GIS: The Arcpad Way. EsriPr; Illustrated edition

Code: GE 305 Research Methodology and project management		
No. of Credits: 02		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Research: Definition, Types (Pure and Applied) Classification, Literature review.	2
2	Routes of Explanation: Inductive and Deductive, Hypothesis, Theories, Laws and Models	1
3	Research Question, Objectives and Significance of Research, Research Design: Data Collection and Analysis	2
4	Presentation of Research Findings: Report Writing and Presentation, Report writing in LaTeX	5
5	Scientific Journals (Impact Factor, Citation), Introduction to EBSCO, Mendeley and Google scholar	2
6	Ethics in Scientific Research & Plagarism	1
7	Introduction to Project Management	2

Books:

1. Montello, D., & Sutton, P. (2013), *An Introduction to Scientific Research Methods in Geography and Environmental Studies*. SAGE Publications.
2. Gomez, B., & Jones, J. P. III (2010). *Research Methods in Geography: A Critical Introduction*. John Wiley and Sons.
3. Warf, B. (Ed) (2006). Encyclopedia of Human Geography. London: SAGE Publications.
4. Goudie, A. (Ed) (2004). *Encyclopedia of Geomorphology*. London: Routledge.
5. Gregory, D., Johnston, R., Pratt, G., Watts, M. & Whatmore, S. (2009). *The Dictionary of Human Geography*. Singapore: Wiley-Blackwell.

Code: GE 306	**Programming in .NET**	
No. of Credits: 03		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Introduction to .NET Language: .Net Architecture. CLR, CLS, CTS, JIT Compiler, C # .Net: Introduction to C# .Net. Syntax Used in Defining Classes, Methods,Variables	5
2	Interface Abstract Class: Understanding Abstract Classes, Access Modifiers and Interface. Creating and using Custom Interfaces, Sample Programs	4
3	Implementation of OPP: Windows Forms and Console Application. Introduction to Classes Used In .Net, Implementing Oops Characteristics, Working with Windows Forms Application, Console Application, Building Logic in the Sample Application.	4
4	Event Handling: Handling Various Events in Windows Forms ApplicationException Handling: Usage of Try, Catch and Finally Block..Net Interoperability: Working with Managed and Unmanaged Code	3

Books:

1. Evjen, B., Hollis, B., Rockford, L. (2006). *Professional VB.NET (2003)*, Wiley Publishing Inc.
2. Holzner, S. (2010). *Visual Basics.NET Programming Black Book*, Paraglyph Press USA Dreamtech Press

Code: GE 307	**Application in Hydrology and Agriculture**	
No. of Credits: 03		**No. of Practical: 15**
Sr.No.	**Topic**	**Practical**
1	Water Resources:Watershed Hydrology, Physical Processes in Watershed, Principles of Remote Sensing in Water Resource Assessment, River Valley Project, Planning, Organization and Design of Spatial and Non-Spatial Data in Water Resource Engineering.Hydrological Modeling, Water budget, Hydrolocigal cycle, ground water management	5
2	Marine Sciences:Fundamentals of Marine Ecology, Bio-Resource Monitoring and Mapping, Coastal Bathymetry.Ocean Color Mapping, SST Mapping, Potential Fishing Zone Mapping.	3
3	Agriculture and Soils: Spectral Characteristics of Crop, Crop Inventory, Crop Yield Modeling, Physiographic, Soil Mapping, Crop Water Management, Agro-Ecological Zoning, Land Evaluation, calculation of various indices, Site-Suitability for agriculture	2
4	Biodiversity: Concept Of Ecology and Biodiversity, Biodiversity Management and Conservation Using Geospatial Technology. Biodiversity Mapping, Assessment of Biodiversity Hotspots, Anthropogenic Disturbance and Modeling Species Distribution. Landscape Analysis, Wildlife Habitat Suitability Analysis, Species Inventory	5

Note: a) For 3 credits 3 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Books:

1. SPRS Technical Commission VII(2002). *Symposium on Resource Environmental Monitoring*, ISRS Annual Convention. Dehradun: IIRS.
2. Deekshatulu, B. L. (1990). *Description and use of Land use/Landcover*. Hyedrabad: NRSA.
3. Sudershana, R. Mitra, D. Mishra, Roy, P.S., Rao, D. P. (2000). *Subtle Issues in Coastal Management*. Dehradun: IIRS.
4. Harris, J. E. (1990). *Earthwatch – The Climate from space*. Midsower Norton: Ellishorwood Ltd.
5. Lal, D. S. (1998). *Climatology*. Allahabad: Chaitanya Publishing House.
6. Escalante, R. B. (2012). *Remote Sensing- Advances techniques and Plateforms*. Intech, Rijeka Croatia.
7. Escalante, R. B. (2012). *Remote Sensing Application*. Intech, Rijeka Croatia.
8. Roy, P.S., Dwivedi, R. S. (2010). *Remote Sensing Application* www.nrsc.gov.in/Learning- Center, E Book. html

Code: GE 308	**Java Scripting**	
No. of Credits: 03		**No. of Practical: 15**
Sr. No.	**Topics**	**Practical**
1	Introduction to Java Script, Importance of Java Script, Creating Sample Program. Data Type Operators: Various Data Type and its Importance. Understanding and Using Various Types of Operators.	5
2	Iterative Mechanisms: Various Looping Mechanism, Understanding Loops, If Else and Switch Case Binding: Creating Dynamic Web Pages Understanding DOM API, Dojo Frameworkand Digits. Debugging in Web Application: Working With Developer Tools In Browser, Layout Engines Used in Various Browsers.	5
3	Introduction to ArcGIS API and Google API., Clientlibraries,Services.	5

Books:

1. Balagurusamy, E. (2011). *Programming with JAVA- a Primer*. New Delhi: Tata-McGraw Hill Education Pvt. Ltd.
2. Horton, I. (2008). *Beginning Java 2*. New Delhi: Wiley-India Inc.
3. Holzner, S. (2008). *HTML Black Book*. Dreamtech Press, India Paraglyph Press, USA

Code: GE 309	**Applications in Atmosphere, Health and Energy**	
No. of Credits: 03		**No. of Practical: 15**
Sr. No.	**Topic**	**Practical**
1	Fundamental Principles of Climatology, Structure, Chemical Composition of the Atmosphere, Aerosols, General Circulation, Climate Modeling, Meteorological Satellites.Forecasting of Natural Calamities.Air Pollution Modeling, Urban heat Islands, Thermal comfort indices.	5
2	Health GIS: Identification of Health Trends,tracking the Spread of Infectious Disease, Improvement in health Services using GIS , Health Care Geographic, Health care network, Public and personal health using GIS	5
3	Energy: Renewable energy: mapping of solar potential of rooftops, site suitability for windmills and panels, network of electricity transmission and distribution, decision support system, solar radiation estimation tools	4
4	GIS for banking and Insurance sector	1

Books:

1. NRSA (2002). *Symposium Tutorial on Sustainable Agriculture* (Volume of Lectures). Hyedrabad.
2. NRSA (2001). *National Agricultural Drought Assessment Monitoring System*, India, Summary Report. Hyedrabad.
3. Roy, P. S. (2000). *Natural Disaster their Mitigation*. Dehradun: IIRS.
4. ISRS and IARI (1990). *Proceedings of National Symposium on RS for Agricultural Application*, New Delhi
5. Roy, P. S. (2002). *Biodiversity Characteristics at Landscape Level in North East using satellite Remote Geographical Information System*. Dehradun: IIRS.
6. Roy, P. S. (2000). *Biodiversity Environment*. Dehradun: IIRS.
7. ISRS (2000). *National Symposium on Spatial Technologies for Natural Hazards Management*, IIT, Kanpur
8. Nirupama, (2002). *Role of Remote Sensing in Disaster Management*, ICIR Research Paper Series N0. 21, Institute for catastrophic loss reduction, University of Western Ontario, Ontario
9. Escalante, R. B. (2012). *Remote Sensing- Advances techniques and Plateforms*, Intech, Rijeka Croatia
10. Escalante, R. B. (2012). *Remote Sensing Application*, Intech, Rijeka Croatia
11. Roy, P.S., Dwivedi, R. S. (2010). *Remote Sensing Application* www.nrsc.gov.in/Learning- Center, E Book. html

Code: GE 401	**Project Work**
No. of Credits: 20	
Sr. No.	**Topics to be Covered**
1	Problem Identification and Literature Review
2	Data Acquisition / Collection
3	Field Work/Validation
4	Data Processing
5	Results and Interpretation
6	Report Writing
7	Presentation