KUVEMPU UNIVERSITY
DEPARTMENT OF APPLIED GEOLOGY
SYLLABUS (CBCS)
M.Sc., in REMOTE SENSING AND GIS APPLICATIONS
(2022-23)

CourseStructure

Code	PaperTitle	Credit	Marks		Total
			InternalAssessment	Main Exam	
ISemester					
GIH101	Earth Science -I	4	25	75	100
GIH102	PrinciplesofGeoinformatics	4	25	75	100
GIH103	Hydrogeology and Structural Geology	4	25	75	100
GIS101	WebProgramming,Java,C,Python	4	25	75	100
GIHP101	Mineralogy and Geochemistry	2	-	50	50
GIHP102	Geoinformatics	2	-	50	50
GIHP103	GeomorphologyandStructuralGeology	2	-	50	50
GISP101	WebProgramming,Java,C,Python	2	-	50	50
		24	**100**	**500**	**600**
IISemester					
Code	**PaperTitle**	**Credit**			
GIH201	Earth Science -II	4	25	75	100
GIH202	Geomorphology, Paleontology,IndianStratigraphy,GeologyofKarnataka	4	25	75	100
GIH203	DigitalImageProcessing	4	25	75	100
GIS201	SpatialModelingandAnalysis	4	25	75	100
GIHP201	Petrology	2	-	50	50
GIHP202	Paleontology and Surveying	2	-	50	50
GIHP203	DigitalImageProcessing	2	-	50	50
GISP201	SpatialModelingandAnalysis	2	-	50	50
	InterDepartmentalElective	2	10	40	50
	Internship (Student's Undergone Internship Training At Industries/ Institutions/ Laboratories of Geological Importance)	-	-	-	-
		26	**110**	**540**	**650**
IIISemester					
GIH301	GIApplicationsinEarthandAtmosphericSciences	4	25	75	100
GIH302	GIApplicationsinWaterResources	4	25	75	100
GIH303	GIApplicationsinAgricultureandForestry	4	25	75	100
GIS301	GIApplicationsinUrbanPlanningandDisasterManagement	4	25	75	100
GIHP301	GIApplicationsinEarthandAtmosphericSciences	2	-	50	50
GIHP302	GIApplicationsinWaterResources	2	-	50	50
GIHP303	GIApplicationsinAgricultureandForestry	2	-	50	50
GISP301	GIApplicationsinUrbanPlanningandDisasterManagement	2	-	50	50
	InterDepartmentalElective	2	10	40	50
		26	**110**	**540**	**650**
IVSemester					
GIPW401	ProjectWork	6	-	-	200
GIPV402	VIVAVOCE	2	-	-	50
		8	**-**	**-**	**250**
GIH102	PrinciplesofGeoinformatics	4	25	75	100

GIH 101 **Earth Science - I**

Unit – I: Crystallography **16 hours**
Crystals, crystalline solids, and their formation. Development and importance of Crystallography. Regular arrangement of Points in Space. Symmetry in Translation Rows,Nets, and Lattices. Relation of the Crystal Lattice to the Crystal. Crystallographic Notation for planes and Axes. Study and Measurement of Crystals. Crystal projections and Stereographic projection. Crystal Classes. Space group terminology. Imperfections of Crystals. Aggregates of Crystals and Crystalline Grains. Twinning.

Unit – II: Rock-forming Minerals **16 hours**
Introduction to mineralogy: Definition and classification of minerals. Structural and chemical principles of minerals, chemical bonds, ionic radii, coordination number (CN) and polyhedron. Structure, chemistry, physical and optical characters and paragenesis of mineral groups: Olivine, pyroxene, amphibole, mica and spinel groups, Feldspar, quartz, feldspathoid, aluminum silicate, epidote and garnet groups. Accessory minerals: Apatite, calcite, corundum, scapolite, sphene and zircon.

Unit – III: Ore-forming Minerals **16 hours**
Classification of ore minerals. Physical, Chemical and Optical properties of the following common ore forming minerals Iron, Manganese, Aluminium, Chromium, Copper, Lead, Zinc, Gold, Silver, Platinum. Halides, Sulphides, Oxides, Carbonates, Nitrates, Borates, Sulphates, Chromates, Phosphates Arsenates, Molybdates, Tungstates, Native metals.

Unit – IV: Thermodynamics **16 hours**
Fundamental relationships: Definition and conventions, standard states; laws of thermodynamics-Enthalpy, Entropy, Heat capacity and free energy, concept of equilibrium and equilibrium constant. Partial molar quantities, including chemical potentials, fugacity and activity. Gibbs phase rule, application to mineralogical system. Forsterite-Fayalite; Albite-Anorthite; Albite-Orthoclase. Forsterite-Quartz and Diopside-Anorthite. Principles of Geothermobarometry.

Reference:
1. Berry, Mason, Dietrich, Mineralogy- concepts, descriptions, determinations; 2nd edition, CBS Publishers.
2. Rutley's elements of mineralogy; 27th edition, revised by C.D Gribble, CBS Publishers.
3. Perkins Dexter; Mineralogy; 3rd edition , Pearson Publications
4. William E. Ford, Dana's textbook of Mineralogy; 4th edition, CBS Publishers.
5. William M. White, Geochemistry, 2013, Wiley-Blackwell
6. Krauskopf, K. B. and D. K. Bird. 1995. Introduction to Geochemistry. New York: McGraw-Hill.
7. Klein, C and Hurlbut, Jr., C.S. 1993; Manual of Mineralogy. John Wiley
8. Introduction to the Rock-forming Minerals Paperback –2013 W. A. Deer (Editor), R. A. Howie (Editor), J. Zussman (Editor)
9. Maureen M. Julian, Foundations of Crystallography, Taylor & Francis Group (2008)
10. C. Hammond, The Basics of Crystallography and Diffraction, Oxford University Press, 2009

GIH 102   Principles of Geoinformatics

Unit I: Aerial Photography   **16 Hours**
History and Principles, Types of aerial photography, Cameras, films and filters, Geometry Image measurements and refinements, Vertical photographs, Instruments and Measurements in Aerial Photography, Laser scanning systems, Application of Aerial Photography

Unit II: Photogrammetry   **16 Hours**
Elementary methods of Planimetric mapping for GIS, Titled and oblique photographs, Introduction to analytical photogrammetry, Topographic mapping and spatial data collection, Vertical Exaggeration, Relief Displacement, Control for aerial photogrammetry, Aero triangulation, Project planning, Terrestrial and close-range photogrammetry. Aerial Photo Interpretation

Unit III: Remote Sensing   **16 Hours**
Energy Sources, Electromagnetic Radiation, Thermal Emissions, Interaction with Atmosphere and Earth features, Remote sensing platforms and sensors. Image Resolution.

Unit IV: Remote Sensing   **16 Hours**
Thermal Remote Sensing, Data Analysis, Basic Principles of Visual Interpretation, Microwave Remote Sensing, Radar Technology and terrain Interactions.

References:
1. ELEMENTS OF PHOTOGRAMMETRY, 3rd edition, by P. Wolf and B. Dewitt, McGraw-Hill Book Co.
2. MANUAL OF PHOTOGRAMMETRY, 5th edition, American Society of Photogrammetry.
3. PHOTOGRAMMETRY, 3rd edition, by F. Moffitt and E. Mikhail, Harper & Row, Inc
4. Principles and Applications of Photogeology, Shiv N Pandey
5. Remote Sensing: Principles and Interpretation, 3rd Edition, Floyd F. Sabins
6. James B. Campbell & Randolph H. Wynne. Introduction to Remote Sensing, The Guilford Press, 2011.
7. Lillesand T.M & Kiefer R.W., Remote Sensing and Image Interpretation, John Wiely and Sons,
8. Introductory Digital Image Processing: A Remote Sensing Perspective: By J.R. Jensen 4th Edition Prentice Hall Pub (2015).
9. Remote Sensing of Environment: An Earth Resources Perspective: By J.R. Jensen 2nd Ed., Upper Saddle River, NJ: Prentice Hall, 592 pages (2012).
10. Rees, W. G., Physical principles of Remote Sensing, Cambridge University Press, 2001
11. Paul Curran P.J., Principles of Remote Sensing, ELBS Publications, 1985.

GIH103	Hydrogeology and Structural Geology	4	25	75	100

GIH 103 Hydrogeology and Structural Geology

Unit – I: **16 hours**
Surface Water Hydrology: Global distribution of water. Hydrological Cycle - Precipitation, Interception, Infiltration, Soil Moisture, Evaporation, Evapotranspiration: Potential and actual evapotranspiration and Runoff. Measurement of runoff, factors controlling runoff.
Groundwater Hydrology: Introduction and definition, occurrence origin and classification. Vertical distribution of water in the crust: Zones of Aeration - Soil moisture zone, vadose zone, Capillary fringe. Zone of saturation - water table, fluctuation of groundwater level, water level measurements and interpretation.
Water bearing characteristic of rocks: Porosity, Effective Porosity, Permeability, Transmissivity, Storage Coefficient, Specific Yield, Specific Retention.
Definitions and hydrologic properties: Groundwater reservoirs - Aquifers - Confined, Unconfined and Perched aquifers, Aquiclude, Aquifuge, Aquitard, Coastal Aquifers, Fresh and salt-water relationships in coastal and island areas.

Unit – II: **16 hours**
Groundwater flow: Laminar flow and Turbulent flow, Darcy's Law, Experimental verification, range of validity, Reynold's number. Flow lines and equi-potential lines, Preparation of groundwater contour maps and Flow nets. Basic Groundwater flow equations: Steady and Unsteady state of flow.
Well Hydraulics: Steady radial flow to a well, Confined aquifer, unconfined aquifer, Dupit's approximation. Unsteady radial flow to a well: Confined aquifer. Unconfined aquifer. Theis's non-equilibrium equation, Jacob's solution.
Pumping Test: Aquifer test and well test for determination of the formation and well loss coefficients. Multiple drawdown tests, well efficiency, selection of test sites

Unit – III: **16 hours**
Introduction, Rock deformation, Mechanical principles and properties of rocks and their controlling factors. (Confining pressure, temperature, time, pore fluid pressure etc). Stress and Strain in Solids. Two dimensional stress analyses. Concept of strain. Homogeneous and inhomogeneous strain. The fundamental strain equation. Two dimensional strain analysis. Types of strain ellipses and ellipsoids, their properties and geological significance. Dip and strike, Compass Clinometers, Lineation, foliations, dykes and lineaments. Unconformity.

Unit – IV: **16 hours**
Definition and importance of structural Geology.
Primary Structures: Ripple marks, Sun cracks, Rain prints, Stratification, Current bedding and Graded bedding. Their importance in identifying secondary structures.
Secondary structures:Folds – types of folds and their classification – Ramasay's classification of folds and their recognition of folds in the field. **Joints** - Description, morphology, genetic and geometric classification. **Faults** – Causes, mechanism and dynamics of faulting. Fault types, their genetic and geometric classifications. Faults recognition in the field.

Reference:
1. Groundwater Hydrology (2nd Ed.) – D.K.Todd – John Wiley and Sons Inc. New York.
2. Hydrogeology (2nd ed.) – C.W.Fetter – Merrill Publishing Co. U.S.A.
3. Hydrogeology - K.R.Karanth – Tata McGraw Hill Publishing Co. Ltd.

4. Ground Water Assessment, Development and Management – K.R.Karanth– Tata McGraw Hill Publishing Co. Ltd.
5. Groundwater – H.M.Raghunath – Wiley Eastern Limited
6. Hydrology – H.M.Raghunath– Wiley Eastern Limited
7. Elements of Hydrology – V.P.Singh
8. Engineering Hydrology – K.Subramaniam - Tata McGraw Hill Publishing Co Ltd.
9. Applied Hydrology – Mutreja, K.N. - Tata McGraw Hill Publishing Co. Ltd.
10. Marland P Billings – Structural Geology 3rd edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey
11. Haakon Fossen- Structural Geology, 2nd edition, Cambridge University Press
12. George H. Davis, Stephen J. Reynolds, Charles F. Kluth : Structural Geology of Rocks and Regions: John Wiley & Sons, INC.

GIS 101   Web Programming, Java, C, Python

Unit I: C Programming 16 Hours
Introduction to C: Understanding Compiler. Input /Output functions: Console input output, Formatted input output. Data types and operators: types and uses of various operators. Control structures: Various looping mechanism, types of loops. Introduction to Array: Understanding Array, Working with Single multidimensional array. Limitations of array, Structure Unions. Introduction to functions: Need of function, defining, calling function, different types of functions. Understanding of pointer. File handling: Reading and writing the data to file

Unit II: .NET
Introduction: .Net architecture. CLR, CLS, CTS, JIT compiler C # .net: Introduction to C# .net. Syntax used in defining classes, methods, variables Interface abstract class: Understanding abstract classes, access modifiers and interface. Creating and using Custom interfaces, Sample programs Implementing OOP: Introduction to classes used in .net, Implementing OOPs characteristics, Working with windows forms application, console application, building logic in the sample application. Event handling: handling various events in Windows forms application Exception handling: Usage of Try, catch and finally block. .Net interoperability: Working with managed and unmanaged code

Unit III: Arc Objects
SDK development environment, basic customizations, deploying and sharing customizations, Maps and layers, workspaces, geometry operators, graphic elements, Cursors, geoprocessing and Engine SDK,

Unit IV: Python
Introduction to Python: The basic elements of Python, Branching programs, Strings and Input, Iteration. Functions, Scoping and Abstraction: Functions and Scoping, Specifications, Recursion, Global variables, Modules, Files. Testing and Debugging: Testing, Debugging Structured Types, Mutability and Higher-order Functions: Tuples, Lists and Mutability, Functions as Objects, Strings, Tuples and Lists, Dictionaries. Exceptions and assertions: Handling exceptions, Exceptions as a control flow mechanism, Assertions. Classes and Object-oriented Programming: Abstract Data Types and Classes, Inheritance, Encapsulation and information hiding, Some Simple Algorithms and Data Structures: Search Algorithms, Sorting Algorithms, Hashtables

References
1. Allen Downey, Jeffrey Elkner and Chris Meyers "How to think like a Computer Scientist, Learning with Python", Green Tea Press

2. Swaroop C H. "A Byte of Python", http://www.swaroopch.com/notes/python
3. "Python Programming", http://en.wikibooks.org/wiki/Python_Programming
4. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
5. Learn Python the Hard way", http://learnpythonthehardway.org/

GIH 201   Earth Science - II

Unit – I   **16 hours**
Igneous Petrology-Introduction: Definition and classification of rocks based on mode of formation, Classification of igneous rocks: Mode, CIPW norm, IUGS and Irvine-Barger classifications; Crystallization of binary systems. Igneous Rocks: Magmatic evolution: Differentiation; Forms, Textures, and structures of igneous rocks. Structures and textures: Magmatism and tectonics.
Origin, distribution and significanceof Igneous rocks –Acid Igneous rocks- Granites, Adamellites and Granodiorites, Syenites and related Alkali-rich rocks, Intermediate rocks-Diorites, Microdiorites and Andesites, Monzonite, Basic Igneous rocks- Gabbros, Norite, Dolerites and Basalts. Feldspathoidal rocks and related rocks, Carbonatites, Lamprophyres, Ultramafites, Anorthosites, Pyroclastic rocks. Ophiolite suite.

Unit – II   **16 hours**
Sedimentary Petrology: Sedimentary processes and their products. Classification of sediments. Diagenesis & Lithification. Sedimentary structures. Classification of sedimentary rocks. Mineral composition, structure and textures of Clastic and non-Clastic sediments and Residual deposits. Origin, occurrence, and characteristics of common sedimentary rocks – Rudaceous, arenaceous, Argillareous and carbonates.

Unit–III   16 hours
Metamorphic Petrology: Types and factors of metamorphism. Zones, grades and facies of metamorphism. Facies of Regional and contact metamorphism. Textures and structures of metamorphic rocks. Metamorphism of argillaceous, arenaceous, calcareous and acidic and basic igneous rocks. Metasomatism. Composition, origin and mode of occurrence of Gneisses, Amphibolites, Granulites, Schists and Eclogites.

Unit-IV
Geochemistry-
Introduction to Geochemistry- Elements, Atoms, and Chemical Bonds, a Brief Lookat the Earth Principles of Geothermobarometry, Aquatic Chemistry- Carbonates, Surface water and Groundwater Chemistry, Alkalinity, Trace Elements in Igneous Processes: Behavior of the Elements, Goldschmidt's Classification Trace Element Distribution during Partial Melting, Trace Element Distribution during Crystallization, Trace Element Distribution during CrystallizationRadiogenic Isotope Geochemistry: Basics of Radiogenic Isotope Geochemistry,Decay Systems and Their Applications- Rb-Sr, Sm-Nd, Lu-Hf, Re-Os, U-Th-Pb, C,Stable Isotope Geochemistry- C, S, and O isotope geochemistry.

Books for Reference
1. Petrology of the Igneous rocks, 13th edition, F.H. Hatch, A.K. Wells and M.K. Wells
2. Igneous And Metamorphic Petrology – Turner and Verhoogan
3. Text book of Petrology – G W Tyrrell
4. Petrology – Hyndman

5. Igneous and Metamorphic Petrology – Myren G Best
6. Petrology (Igneous, Sedimentary and Metamorphic) – Eenest G Ehlers/Harvey Blatt
7. Igneous Petrology- McBirney
8. Principles of Igneous and Metamorphic Petrology- Anthoney R Phillpots
9. Igneous Petrology – M K Bose
10. Petrology of Igneous rocks – Alokh K Gupta
11. Metamorphism and Metamorphic rocks – Miyashro
12. Metamorphic Petrology – B Bhaskar Rao
13. Sedimentary Petrology – Pettijohn
14. Igneous and Metamorphic Petrology – W D Winter
15. Petrology (Igneous, Sedimentary and Metamorphic) – Loren A Raymond
16. Krauskopf, K. B. and D. K. Bird. 1995. Introduction to Geochemistry. New York: McGraw-Hill.
17. William M. White, Geochemistry, 2013, Wiley-Blackwell

GIH 202   Geomorphology, Paleontology, Indian Stratigraphy, Geology of Karnataka

Unit – I: Geomorphology   16 hours

Introduction: Fundamental concepts of geomorphology. **Geomorphic processes:** Weathering, Types of weathering, Zone of weathering and Erosion, transportation, deposition **Geomorphic controls:** Geology and structure, climate and biogenic **Landforms of exogenetic origin:** Fluvial Process and landforms Wind action and Aeolian landforms, Glaciers and Glacial landforms, Marine erosion and Coastal landforms. **Landforms of endogenetic origin**- Volcanic and Tectonic landforms. Landforms of biogenetic and extraterrestrial activity origin; Termites Man made structure like quarries, road cuts and fills.

Mass wasting: Classifications, Causes geomorphic significance and conservation of mass wasting, Morphology of Indian sub-continent Morphology of the ocean floor**. Soil as a resource:** Soil uses, component and profiles. Soil formation processes. Physico - chemical parameters of soil, Classification of soils. Soils erosion, conservation practices, preventive measures.

Unit – II: Paleontology   16 hours
Introduction: Classification of life -plant kingdom and Animal kingdom-vertebrate and invertebrate –phylum, class, order, general and species.
Fossils: Definition, Mode of preservation of fossils, physico-chemical conditions for fossilization, types of fossils, significance of fossils, and imperfection of geological record,
Invertebrates: Morphology, classification evolutionary trends, and Geological distribution of Foraminifera, Cnidarians, Bryozoa, Brachiopods, Lamellibranch, Gastropods, Cephalopods, Echinoids Trilobites& Graptolites.
Plant fossils-Introduction, classification, Morphology and distribution of Lepidodendron, sigillaria, calamities, Glossopteris, ptilophyllum.

Unit – III: IndianStratigraphy   16 hours
Principles of stratigraphy, Geological time scale, Stratigraphy classification, stratigraphic units of India, Physiographic Units of India.

Archean system-, Dharwar super group-lithology and structure, Classification – distribution of Archean rocks in Indian continent and economic importance.
Proterozoic formations-Cuddapah& equivalents, Vindhyans group & equivalents and economic importance.
Paleozoic group- Cambrian rocks, Ordovician and Silurian rocks, Devonian rocks, Permo-Corboniferous rocks. Mesozoic group-Triassic rocks, Jurassic rocks, Cretaceous rocks-Gondwana super group and economic importance. Deccan traps. Tertiary group- Siwaliks and Karewas

Unit – IV: GeologyofKarnataka 16 hours

Summary of Geological history of Karnataka, Archean rocks, Ancient supra crustal rocks – Sargurs, Gneissic complex, gold bearing schist belts of eastern Karnataka, schist belts of western Karnataka, Granulite, Younger granites. Purana BasinsKaladgi and Bhima group, Gondwana group, Deccan volcanism, Dykes rocks. Tertiary rocks laterite and Black soil.

Reference:
1. Geology of Karnataka- B P Radhakrishna and R Vaidyanadhan Geol. Soc. India Publ
2. Memoire 112 Geological Survey of India Publication
3. Geology of India by DN Wadia
4. Geology of India and Burma by M S Krishnan
5. Historical Geology and Principles of Stratigraphy by Ravindra Kumar
6. Paleontology: The Record of Life COLIN W. STEARN Logan Professor of Geology McGill niversity ROBERT L. CARROLL Strathcona Professor of Biology McGill University with illustrations by Linda Angeloff Sapienza
7. Text-book of Paleontology edited by Charles r. Eastman, A.M.,
8. Palaeontology –Evolution and Animal Distribution by Dr. P C Jain and Dr. M S Anantha Raman-Vishal Publications.
9. Robert R.Shrock and William H., Twenhofel, (1953) Principles of Invertebrate Palaeontology Mc Graw-Hill Book Co-Invertebrate Paleontology, H.Woods, Cambridge University press, 1961
10. R.C.Moore, C.G., Lalicker and A.G. Fisher, 1952. Invertebrate Fossils Mc Graw Hill Book Co., Alfred S.Romer (1963) Vertebrate Paleontology, , University of Chicago press
11. B.U.Haq and A.Boerma, 1978, Introduction to Marine Micropaleontology, Elsvier Publishing Company. M.D., Brasier, 1980, Microfossils, George Allen & Unwin, London.
12. G.Bigot, 1985, Elements of Micropaleontology, Grahm& Trotman, London
13. H.H.Swinerton, (1961) Outlines of Paleontology, Edward Arnold PublisherReference Books
14. Derek V.Ager, 1963, Principles of Paleoecology, McGraw Hill Book Co.Benton, M.J. 1990, Vertebrate Paleontology, John Wiley, Unwin Hyman, , 1971, Vertebrate Paleozoology, John Wiley
15. F.B.Phleger, Ecology and Distribution of Recent, Foraminifera, Hohn Hopkins Press.
16. J.P.Kennet and M.S.Srinivasan; 1951, Forminifera, W.H.Freeman& Co.,

GIH 203   Digital Image Processing

Unit-I: Digital Image Processing 16 hours

Data collection, data analysis, data collection errors, Remote sensing data requirements, image processing functions, image data formats. Remote Sensing Data Collection: Analog image digitization, Digital Remote Sensor Data collection, Multispectral Imaging, Imaging Spectrometry, Digital Image data formats. Image quality assessment: Image processing, Mathematical notations, Sampling theory, Histograms and its significance in digital image processing, Image Metadata, Univariate descriptive image statistics, Central tendencies in remote sensing data, measures of dispersion, measures of distribution, multivariate statistics, geostatistical analysis.

Unit-II: Digital Image Processing 16 hours
Image Rectification and Restoration: Geometric correction, geometric errors, types of geometric corrections: Image to map, Image to Image, hybrid approach, rectification logic, Mosaicking. Image enhancement: Image reduction and magnification, contrast enhancementlinear and nonlinear enhancements, Band rationing, spatial filtering- spatial convolution filtering, Fourier transformation, principal component analysis. Thematic Information extraction: Supervised classification – Land use and Land cover classification schemes. Training site selection and statistical extraction. Feature selection of classification algorithm. Unsupervised classification methodsChain and ISODATA methods, cluster busting, Fuzzy classification.

Unit III 16 Hours
Display Alternatives and Visualization: Image Display, Temporary Video Image display, merging remotely sensed data, Distance, Area and Shape measurements. Information Extraction Artificial Intelligence: Expert Systems, Neural Networks Digital Change Detection: Steps required to perform Change Detection, Change detection Geographic region of Interest. Change detection time period. Hard and Fuzzy change detection logic, per pixel or object oriented change detection, Change detection Algorithm.

Unit IV
Hyperspectral Sensing: Spectral Characteristics, Hyperspectral sensors, Processing of Hyperspectral data, Geological Applications of hyperspectral data. Thematic map accuracy: Land use/Land cover map accuracy assessment, sources of errors in remote sensing derived thematic products, error matrix, sampling size and design, evaluation of error matrices, geostatistical analysis to assess the accuracy of remote sensing derived information.

References:
1. Introductory Digital Image Processing: A Remote Sensing Perspective: By J.R. Jensen 4th Edition Prentice Hall Pub (2015).
 2. Remote Sensing of Environment: An Earth Resources Perspective: By J.R. Jensen 2nd Ed., Upper Saddle River, NJ: Prentice Hall, 592 pages (2012).

GIS 201   Spatial Modeling and Analysis

Unit I   **16 Hours**
Introduction, fundamentals, functions and Components of GIS. Data and information. Maps and spatial information, coordinate systems of the earth, Map Projection: Earth's size and shape in time and space. Properties of map projections, Types of basic projections classification - Cylindrical, Conical and Azimuthal projections.

Unit II   **16 Hours**
Raster and Vector data models. Spatial data structures, Topology, Data quality and errors, Map algebra. Overlay analysis. Proximity analysis. Data Conversions. Surface Analysis.

Unit III   **16 Hours**
Network analysis, Neighborhood Analysis, Pattern analysis. Site suitability analysis. Representation of raster surfaces.3D Visualization. Applications of DEM

Unit IV   **16 Hours**
Introduction to GPS, History, Satellite Navigations constellations, GPS Errors. Reference Systems and Coordinate systems. Structure of GPS Signal. GPS Observables. Surveying with GPS, Data Processing, GIS and GPS data integration, Navigation with GPS, Atmospheric Effects on GPS Signal, and Applications of GPS.

REFERENCES:
1. Concepts and Techniques of Geographic Information Systems - C.P.Lo, Albert K.W. Yeung
2. Principles of Geoinformation sytems – Burrough and Rachel
3. Geographical information system and Science – Goodchild and Longley
4. Geographical Information Science, P.S.Roy
5. Geographic Information System – Bhatt
6. John E. Harmon & Steven J. Anderson., The design and implementation of Geographic Information Systems, John Wiley & Sons, 2003.
7. Kang Tsung Chang., Introduction to Geographic Information Systems, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2008
8. Hofmann W.B &Lichtenegger, H. Collins., Global Positioning System – Theory and Practice, Springer-Verlag Wein, New York,2001.
9. Gunter Seeber., Satellite Geodesy Foundations-Methods and Applications,2003