KUVEMPU UNIVERSITY

M.Sc. in GEOINFORMATICS

(Choice Based Credit System)

Department of PG Studies and Research in Applied Geology
Jnanasahyadri
Shankaraghatta – 577 451

Preamble:

The Department of PG Studies and Research in Applied Geology, a nodal centre for Earth Science and Resource Management Studies (recognized by UGC under Innovative Programme), offering innovative and multidisciplinary PG and Research programs leading to M.Sc. and PhD degrees. The Department is assisted by UGC (Innovative and SAP (DRS) I, II and III) and Department of Science and Technology (FIST) programs. The Department has established well equipped mineralogy lab with polarizing microscopes, geochemical laboratory with sophisticated Atomic Absorption Spectrophotometer, Remote Sensing and GIS laboratories with High-end computers and licensed image processing and GIS software like ArcGIS, ERDAS, PCI Geomatica, ITTVIS ENVI, MapInfo along with many open source software. The department also has many digital, analog satellite images and aerial photographs needed for its academics and research. The Department has ICT enabled classrooms with multimedia facilities and a library with more than 350 text books.

Mission

To prepare students to understand and manage our Earth and its resources for the sustainable future.

Vision

As a nodal center recognized by UGC the department intends to be a nationally recognized through its education and research programs in Earth Science and Resource Management. The program emphasizes to produce well-trained competent, academic and professional geoscientists capable of the developing new innovative technology in understanding and sustainable management of Earth and its resources.

Values

- Research at the highest international level
- Smart and attractive courses and facilities leading to appropriate competencies.
- Qualifying students for attractive positions in the public and private sectors.

Eligibility

A Bachelor's Degree in Science, Bachelor's degree with Geography at UG level, Engineering (Civil, Environmental, Mining, Geotechnical, Geoinformatics), B.Sc (Agriculture, Forestry, Horticulture, Soil Science) from any Indian university or equivalent qualification recognized by Kuvempu University. Eligibility for Foreign students will be in accordance with the university regulations. The general admission criteria are based on Kuvempu University guidelines.

Intake: As per university rules

Course Credits

One credit means 1 hour teaching for theory and Two-hours teaching for practicum.

Duration

A two years master's degree (Four semesters) offered under choice-based credit system with an integrated-multidisciplinary approach. The curriculum focuses on the application based geological studies.

Attendance

A minimum of 75% attendance is mandatary and as per Kuvempu University rules

Internship:

The students have to undergo 15 to 30 days Internship in reputed organizations/institutions based on student's choice and interest after the 2nd Semester.

Project report and viva voce:

Students will have to submit an individual Project Report/dissertation at the end of the IV semester, which will be evaluated by internal/supervisor and external examiners. There is no financial commitment on the part of the department/University for the project work. However, the Candidates belonging to SC/ST/OBC, the provisions made by the university are applicable. The Department/University may assist the candidate in locating him/her an appropriate place to carry out the project work in reputed institutions. The duration of the project will be for 4 months/one semester. The dissertation will be evaluated by two examiners consisting of a supervisor and one external, outside the University for 4 Credits consisting of 200 marks. The candidate will have to defend his/her dissertation in an open viva examination for 2 credits and for 50 marks.

Internal Assessment

There will be an internal assessment of 25 marks for every theory paper; the assessment is based on the student's continuous evaluation consisting of Assignments, seminars, two internal tests and attendance. The internal assessment marks will be brought to the notice of students at regular interval during the course of the semester. There will be no internal assessment for practical examinations and project work.

Examination

At the end of the semester, theory and practical examinations are conducted as per the university guidelines. The practical examination is of 3 hours duration will have a viva voce.

M.Sc. in Geoinformatics

Course Structure

Code	Paper Title	Credit	Marks		Total
			Internal Assessment	Main Exam	
I Semester					
GIH 101	Earth Science - I	4	25	75	100
GIH 102	Principles of Geoinformatics	4	25	75	100
GIH 103	Introduction to GIS	4	25	75	100
GIS 101	Web Programming, Java, C, Python	4	25	75	100
GIHP 101	Mineralogy, Geomorphology and Structural Geology	2	-	50	50
GIHP 102	Geoinformatics	2	-	50	50
GIHP 103	GIS	2	-	50	50
GISP 101	Web Programming, Java, C, Python	2	-	50	50
		24	**100**	**500**	**600**
II Semester					
Code	**Paper Title**	**Credit**			
GIH 201	Earth Science - II	4	25	75	100
GIH 202	Spatial Modeling and Analysis	4	25	75	100
GIH 203	Digital Image Processing	4	25	75	100
GIS 201	Resource Mapping and Surveying	4	25	75	100
GIHP 201	Petrology	2	-	50	50
GIHP 202	Spatial Modeling and Analysis	2	-	50	50
GIHP 203	Digital Image Processing	2	-	50	50
GISP 201	Resource Mapping and Surveying	2	-	50	50
	Inter Departmental Elective	2	10	40	50
		26	**110**	**540**	**650**
III Semester					
GIH 301	GI Applications in Water Resources	4	25	75	100
GIH 302	GI Applications in Agriculture and Forestry	4	25	75	100
GIH 303	GI Applications in Earth and Atmospheric Sciences	4	25	75	100
GIS 301	GI Applications in Urban Planning and Disaster Management	4	25	75	100
GIHP 301	GI Applications in Water Resources	2	-	50	50
GIHP 302	GI Applications in Agriculture and Forestry	2	-	50	50
GIHP 303	GI Applications in Earth and Atmospheric Sciences	2	-	50	50
GISP 301	GI Applications in Urban Planning and Disaster Management	2	-	50	50
	Inter Departmental Elective	2	10	40	50
		26	**110**	**540**	**650**
IV Semester					
GIPW 401	Project Work	6	-	-	200
GIPV 402	VIVA VOCE	2	-	-	50
		8	**-**	**-**	**250**

Syllabus

I Semester

Code	Paper Title	Credit	Marks		Total
			Internal Assessment	Main Exam	
GIH 101	Earth Science - I	4	25	75	100
GIH 102	Principles of Geoinformatics	4	25	75	100
GIH 103	Introduction to GIS	4	25	75	100
GIS 101	Web Programming, Java, C, Python	4	25	75	100
GIHP 101	Earth Science - I	2	-	50	50
GIHP 102	Geoinformatics	2	-	50	50
GIHP 103	GIS	2	-	50	50
GISP 101	Web Programming, Java, C, Python	2	-	50	50
		24	**100**	**500**	**600**

GIH 101: EARTH SCIENCE - I

Unit-I: Crystallography — 16 Hours

Crystalline and Amorphous forms - Symmetry and Classification of Crystals - System of Crystal Notation - (Weiss and Millerian) - Forms and Habits. Crystal Systems (Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic, and Triclinic), Twinning-crystalline Aggregates – Columnar, Fibrous, Lamellar, and Granular - Imitative shapes and Pseudomorphism. Derivation of 32 Crystal classes based on Schoenfiles notation - Bravies lattices and their Derivation - An outline of Space Groups

Unit II: Mineralogy — 16 Hours

Physical Properties: (Colour – Structure – Form – Luster - Transparency – Streak – Hardness – Specific Gravity – Tenacity – Feel – Taste – Odour) - Electrical, Magnetic and Thermal properties. Empirical and Structural formula of minerals – Isomorphism, Polymorphism and Psudomorphism.Optical Properties (Colour – Form – Cleavage - Refractive Index - Relief – Alteration – Inclusions – Zoning – Pleochroism – Extinction - Polarization colours – Birefringence) – Twinning. Silicate Groups

Unit III: Geomorphology — 16 Hours

Basic Principles of Geomorphology. Process of weathering and Mass wasting, Types of landforms with reference to Aerial photography. Fluvial, Aeolian, Coastal, Glacial and Volcanic.

Unit IV: Structural Geology — 16 Hours

Concepts of stress and strain, Geometry and Mechanics of Folding and Faulting, Joints, Unconformities. Geometric and genetic classification, recognition of secondary structures in the field.

References:

1. Rutleys Elements of Mineralogy- HH Reed
2. Textbook of Mineralogy – Dana. F
3. Text book of Mineralogy - Dexter Parkinson
4. Introduction to Rock Forming Minerals (Condensed Volume) – Deer, Howie and Zussemon
5. Elements of Optical Mineralogy (Part II)– Winchel and Winchel
6. Physical Geology by Montigomerry
7. Principles of Geomorphology by Dayal
8. Principles of Geomorphology, Thornburry
9. Ghosh, S.K. (1993) Structural Geology: Fundamental and Modern Developments. Pergamon Press.
10. Hobbs, B.E., Means, W.D. and Williams, P.F. (1976) An outline of Structural Geology, John Wiley and
11. Sons, New York.
12. Marshak, S. and Mitra, G. (1988) Basic methods of Structural Geology, Prentice-Hall, New Jersey.
13. Ramsay, J.G. (1967) Folding and fracturing of rocks, McGraw Hill.
14. Billings Structural Geology
15. Davis, G.R., 1984: Structural Geology of Rocks and Region-John Wiley.

GIH 102: PRINCIPLES OF GEOINFORMATICS

Unit I: Aerial Photography — 16 Hours

Principles of photography and imaging, Cameras and other imaging devices, Image measurements and refinements, Object space coordinate systems, Vertical photographs, Stereoscopic viewing, Stereoscopic parallax, Stereoscopic plotting instruments, Laser scanning systems

Unit II: Aerial Photography — 16 Hours

Elementary methods of Planimetric mapping for GIS, Titled and oblique photographs, Introduction to analytical photogrammetry, Topographic mapping and spatial data collection, Fundamental principles of digital image processing, Photogrammetric applications in GIS, Control for aerial photogrammetry, Aero triangulation, Project planning, Terrestrial and close-range photogrammetry

Unit III: Remote Sensing — 16 Hours

Sources of Energy, Active and Passive Radiation, Electromagnetic Radiation - Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, and Spectral reflectance of Earth's surface features. The concept of Remote Sensing. Data Acquisition Platforms: Various types of platforms, different types of aircraft, manned and unmanned space crafts

used for data acquisition - characteristics of different types of platforms - LANDSAT, SPOT, IRS, ERS, INSAT and other platforms.
Data Acquisition Sensors (Visible & Infrared), spatial, spectral and radiometric resolution.

Unit IV: Remote Sensing **16 Hours**

Thermal sensors, Geometric Characteristics of thermal imagery, calibration of the thermal scanner, signal to noise ratio. Data Analysis: Data Products and Their Characteristics,
Data Pre-processing – Atmospheric, Radiometric, Geometric Corrections
Basic Principles of Visual Interpretation, Equipment for Visual Interpretation, Ground Truth, Ground Truth Equipment.
Microwave Remote Sensing: Active and Passive Systems, Advantages, Platforms and Sensors, Microwave Radiation and Simulation, Principles of Radar – Resolution, Range, Angular Measurements, Microwave Scattering, Imagery – characteristics and Interpretation.

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. James B. Campbell & Randolph H. Wynne. Introduction to Remote Sensing, The Guilford Press, 2011.
5. Lillesand T.M & Kiefer R.W., Remote Sensing and Image Interpretation, John Wiely and Sons,
6. Introductory Digital Image Processing: A Remote Sensing Perspective: By J.R. Jensen 4th Edition Prentice Hall Pub (2015).
7. Remote Sensing of Environment: An Earth Resources Perspective: By J.R. Jensen 2nd Ed., Upper Saddle River, NJ: Prentice Hall, 592 pages (2012).
8. Rees, W. G., Physical principles of Remote Sensing, Cambridge University Press, 2001
9. Paul Curran P.J., Principles of Remote Sensing, ELBS Publications, 1985.

GIH 103: INTRODUCTION TO GIS

Unit-I: **16 hours**

Introduction, fundamentals and functions of GIS. Components of GIS.
Data and information: Types of geological and natural resources data, spatial and time variant, oriented information. Geographical Information System (GIS): Introduction to Maps and spatial information, Map Scale, Classes of maps, paper

and digital maps, plane coordinate system, geographic coordinate system 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**

Data models: Raster and Vector data models. Advantages and Disadvantages of Raster and Vector Models and GIS data processing. Raster ad vector spatial data structures, Topology – types of errors, editing and rectification. Data quality and errors: Importance of Errors, Accuracy and Precision, Types of Errors, Sources of Inaccuracy and Impression, Problems of Propagation and Cascading, False precision and false accuracy, and dangers of undocumented data.

Unit-III **16 hours**

Spatial Analysis: Types of analysis- point data, line data and polygon data. Extract – Clip, Select, Split and Table select. Overlay analysis – Erase, Identify, Intersect, Spatial join, Union etc. Proximity analysis – Buffer, Multiple Buffers, Thiessen Polygon, point distance. Conversion from vector to raster data.

UNIT IV: GPS **16 Hours**

Introduction: Introduction to GPS, History, Satellite Navigations constellations today – GPS system, GLONASS system, Galileo System, GPS Errors Future of GPS.

Reference Systems and Coordinate systems: Geodetic coordinate systems, Datum transformations, Height systems, Time systems

Satelllite Signal: Structure of GPS Signal, Frequency, P Code, C/A code and data format, Generation of C/A code, Navigation data bits

GPS Observables: Pseudo range measurements, Phase measurements, system accuracy characteristics, DOP, Data formats.

Surveying with GPS: Planning a GPS Survey, Positioning methods – point positioning, relative positioning, Static, Fast static, RTK, Differential

Data Processing: Ambiquity resolution, Post processing, real time processing, Accuracy measures, software modules, GIS and GPS data integration

Surveying with GPS, Navigation with GPS, Atmospheric Effects on GPS Signal, and Applications of GPS.

Future of GPS: Modernization plans of navigational satellites, Hardware and software improvements

References:

1. Paul Longley., Geographic Information systems and Science, John Wiley & Sons, 2005
2. John E. Harmon & Steven J. Anderson., The design and implementation of Geographic Information Systems, John Wiley & Sons, 2003.
3. ArcGIS 10.3 Manuals,
4. Kang Tsung Chang., Introduction to Geographic Information Systems, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2008.
5. Burrough, P.A., Principles of GIS for Land Resource Assessment, Oxford Publications, 2005.
6. C.P.Lo & Albert K. W.Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall India Pvt.Ltd, 2002.
7. Hofmann W.B & Lichtenegger, H. Collins., Global Positioning System – Theory and Practice, Springer-Verlag Wein, New York,2001.
8. Gunter Seeber., Satellite Geodesy Foundations-Methods and Applications,2003

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/

PRACTICALS

GIHP 101: MINERALOGY, GEOMORPHOLOGY AND STRUCTURAL GEOLOGY

1. Mineralogy: Identification of Important Rock forming miners in Hand specimens based on physical properties.
2. Structural Geology: Preparation of geological Maps and Sections. Strata and Thickness, Dip and Strike Problems.
3. Toposheet Reading
4. Preparation of drainage map and Calculation of Morphometry parameters
5. Meandering and Sinuosity Index
6. Preparation of Geomorphology map and Symbols used in Geomorphology map
7. Megascopic study of important metallic ore minerals
8. Megascopic study of industrial minerals- Abrasives, Ceramics, Refractory, Minerals used in chemical & fertilizer industries, minerals used as insulators and paints & pigments

GIHP 102: GEOINFORMATICS

1. Introduction remote sensing
2. Stereoscope & it types
3. Determination of Relative position of the Object
4. Determination of X and Y- Coordinates PP, C P and Flight line
5. Marginal information of the Aerial photograph
6. Determination of area and distance
7. Computing Flying height from vertical photograph
8. Computing Air base from vertical photograph
9. Computing Height of the object by parallax difference method
10. Computing Elevation, Horizontal distance from V.P
11. Computing scale of the vertical photograph flat terrain
12. Computing scale of the vertical photograph variable terrain
13. Computing average scale of the vertical photograph and types of scales
14. Photograph Computing Ground control point from the A.P
15. Computing Relief displacement from vertical photograph
16. Computing height of the tower from vertical photograph
17. Principal Key for the Interpretation of the Aerial photograph
18. Application of Aerial photograph Land use/Land cover
19. Aeolian, Glacial, Fluvial, and Coastal Landforms
20. Tracing of Lineament using Aerial photographs and determination of directions using Rose Diagram
21. Image Interpretation Using visual interpretation keys(Land use/Land cover,
22. Aeolian Landforms, Glacial landforms, Fluvial Landforms, Coastal Landforms)

GIHP 103: GIS

1. Digitization of Maps, editing the data
2. Displaying the data: Classification of spatial data, labeling, creating map layout
3. Querying the spatial and attribute data
4. Preparation of Thematic maps
5. Plotting GPS Data, Working with georeferenced data
6. Geoprocessing: Dissolve features based on attributes, Merging themes together, Clip theme based on another, Intersect two themes, Union two themes, Assign data by location, Buffer analysis and Modeling

GISP 101: PROGRAMMING

II SEMESTER

Code	Paper Title	Credit	Marks		Total
			Internal Assessment	Main Exam	
GIH 201	Earth Science - II	4	25	75	100
GIH 202	Spatial Modeling and Analysis	4	25	75	100
GIH 203	Digital Image Processing	4	25	75	100
GIS 201	Resource Mapping and Surveying	4	25	75	100
GIHP 201	Petrology	2	-	50	50
GIHP 202	Spatial Modeling and Analysis	2	-	50	50
GIHP 203	Digital Image Processing	2	-	50	50
GISP 201	Resource Mapping and Surveying	2	-	50	50
	Inter Departmental Elective	2	10	40	50
		26	**110**	**540**	**650**

GIH 201: EARTH SCIENCE - II

Unit I: Igneous Petrology

Classification of igneous rocks: Tyrrell's tabular, CIPW norm and IUGS rock classification. Magmatism and tectonics: Inter-relationship between tectonic settings and igneous rock suites. Paragenesis: Dunite, peridotite, pyroxenite. Granites, syenite and granitic rocks. Dolerites, basalts ultramafic rocks. Alkaline rocks. Kimberlites. Lamprophyres. Anorthosites. Carbonatites and Ophiolite suite.

Unit II: Metamorphic Petrology

Concept of metamorphism: Types of metamorphism. Factors of metamorphism. Role of fluids. Nomenclature. Metamorphic structures and textures. Classification of metamorphic rocks: Eskola, Fyfe Turner and Verhoogen. Grade classification of Winkler. Facies series. Contact metamorphism. Regional metamorphism. Retrograde metamorphism. Metamorphism of carbonate rocks, pelitic, mafic and ultramafic rocks.

Unit III: Sedimentary petrology

Sedimentation-Weathering, Transportation, Deposition-Lithification and diagenesis. Depositional Environments-Terrestrial, Lacustrine, Fluvial and Marine. Structures of Sedimentary Rock-Ripple Marks. Rain prints, Sun craks, current bedding, Graded Bedding, Stratification. Classification of Sedimentary Rocks,

Study of important sedimentary rocks: Rudaceous – Conglomerate and Breccia. Arenaceous-Sandstone, Grit, Arkoses. Argillaceous- Shale, siltstone.

Chemical and Biogenic: Carbonates & Carbonaceous deposits and Residual Sediments-Laterites.

Unit IV: Economic Geology

Classification of ore deposits -Ore deposits of different important geological settings - Ore deposits of kimberlite & carbonatite affiliations. Ore deposits of pegmatitic environment. Orthomagmatic deposits of chromite, platinum, titanium and iron associated with basic and ultrabasic rocks. Orthomagmatic Cu-Ni-Fe-(platinoid) deposits associated with basic ultrabasic rocks. Porphyry Mo-Cu deposits, Stratiform sulphide, oxide and sulphate deposits of sedimentary & volcanic environments, Vein association & hydrothermal deposits, Sedimentary deposits, Residual deposits and supergene enrichment.

References

1. Igneous And Metamorphic Petrology – Turner and Verhoogan
2. Text book of Petrology – G W Tyrrell
3. Igneous and Metamorphic Petrology – Myren G Best
4. Petrology (Igneous, Sedimentary and Metamorphic) – Eenest G Ehlers/Harvey Blatt
5. Igneous Petrology- McBirney
6. Principles of Igneous and Metamorphic Petrology- Anthoney R Phillpots
7. Igneous Petrology – M K Bose
8. Petrology of Igneous rocks – Alokh K Gupta
9. Metamorphism and Metamorphic rocks – Miyashro
10. Metamorphic Petrology – B Bhaskar Rao
11. Sedimentary Petrology – Pettijohn
12. Igneous and Metamorphic Petrology – W D Winter
13. Petrology (Igneous, Sedimentary and Metamorphic) – Loren A Raymond
14. Craig, J.M. & Vaughan, D.J., 1981: Ore Petrography and Mineralogy-John wiley
15. Evans, A.M., 1993: Ore Geology and Industrial Minerals-Blackwell
16. Stanton, R.L., 1972: Ore Petrography-McGraw Hill

GIH 202: SPATIAL MODELLING AND ANALYSIS

Unit–I: 16 hours

Introduction, significance of spatial Analysis, Using GIS for spatial Analysis, spatial analysis tools in GIS. Vector Based - Various types of overlay analysis operations: Topological overlays, Polygon-in-polygon overlay, line-in-polygon overlay, Point-in-polygon overlay, Logical operations (Boolean operations), Conditional operations, Buffer analysis, Site suitability analysis. Steps for performing Geographic analysis

Unit–II: 16 hours

Raster Based - Introduction, Advantages and disadvantages of raster analysis, Grid operations used in map algebra, important raster analysis operations, Grid based spatial analysis – local, focal, zonal, and global function (Neighborhood analysis).

Conditional, Density – Kernel density, Line density, Point density, Distance – cost distance, Euclidean distance etc., interpolation -IDW, Kriging, Spline, Map algebra, Overlay – weighted overlay, reclassification, surface analysis – aspect, contour, hillshade, slope etc., Zonal analysis.

Unit–III: 16 hours

Introduction to network analysis, Utility Networks, Transportation Networks, Geometric network, Logical Network, Connectivity rules, Network based model, Applications of network analysis

Unit–IV: 16 hours

Introduction, Pattern analysis, Algorithm, Auto correlation –Semi variance, Semi - Variogram model, Kriging.

Qualities of surfaces, Representation of surfaces - Raster and TIN, Digital Elevation Model (DEM), Maps and features derived from DEM, Visualization in 3D analyst, Sources for DEM, Applications of DEM.

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

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 enhancement-linear 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 methods-Chain 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: RESOURCE MAPPING AND SURVEYING

Unit – I: Resource mapping **16 hours**

Resource Survey: Definition, aim and uses. Diversities of surveys – literature survey and collection of secondary data and Primary data: field observations and measurements, tests and through a questionnaire.

Unit – II: Resource mapping **16 hours**

Resource Mapping: Definition aim and scope, significance of mapping,– geomorphology, and drainage, slope, geological (lithology, structural) map, soil maps, infrastructures and settlement location map, Land use/land cover maps, ground water contour maps, mine plan and zonation mapping.

Unit III: Surveying **16 hours**

Fundamentals of Surveying: Principles of surveying, types of surveying, classification of surveys & maps, Plan Vs Map, Accuracy Vs Precision, sources and kinds of error; Least Squares adjustments and applications. Surveying & Levelling: Chains: types, errors in chaining, chain triangulation, basic problems in chain surveying; Compass survey, Plane table: instruments used for plane table survey, methods of plane tabling;

Unit IV: Surveying **16 Hours**

Leveling – definition, leveling instruments, methods of leveling (Dumpy level, Theodolite, Digital Level, Total Station); Tacheometric surveying – principle, methods to determine horizontal distance, uses of Tachometric Surveying. GPS in Surveying

References

1. Principles of Geoinformatics – R.K Gupta & Subhash Chander Publication. - 2005
2. Surveying and Levelling – T.P Kanetkar & S.V kulkarni 1984
3. Methodology for Land use planning- N.C Goutham - 2001
4. Technical Guidelines for mapping- IRIS – DA NRSA-Hyderabad 2003
5. Rajiv Gandhi National drinking water mission –technical guidelines for preparation of ground water prospect map NRSC- 2003
6. Integrated Mission for Sustainable Development- Technical Guide lines NRSC-1995

PRACTICALS
GIHP 201:PETROLOGY

1. Study of megascopic structures
2. Megascopic study of Igneous rocks ;Granite-Granodiorite-Diorite, Syenites, Ultramafic rocks, lamrophyres, dolerites, pegmatites and Basalts

3. Megascopic study of sedimentary rocks-rudaceous, arenaceous, calcareous and argillaceous rocks.
4. Megascopic study of metamorphic rocks;-Schists, gneisses, amphibolites and granulites

GIHP 202: SPATIAL MODELLING AND ANALYSIS

1. Spatial data query – based on attributes
2. Spatial query – based on location
3. Spatial data query - based on condition, Boolean operation, multiple queries.
4. Spatial data query - Location suitable site based on attributes and location.
5. Spatial data query – raster data – mathematical operations, logical conditions, and
6. Boolean operations.
7. Topological overlay analysis – Vector data
8. Overlay analysis – Raster data
9. Neighborhood analysis
10. Network analysis

GIHP 203: DIGITAL IMAGE PROCESSING

1. Introduction to the Remote Sensing Process
2. Image Display and Cursor Operations
3. Data Formats, Contrast Stretching, and Density Slicing
4. Image Statistics Using Spatial Modeler
5. Image Annotation and Map Composition
6. Radiometric Correction - Empirical Line Calibration
7. Geometric Corrections
8. Spectral Enhancements: Band Ratioing and Image Filtering
9. Spectral Enhancements: Image Indices and PCA
10. Image Classifications
11. Change Detection of Coastal Vegetation & the Spatial Modeler

GISP 201: RESOURCE MAPPING AND SURVEYING

1. Land use land cover Mapping
2. Geomorphological Mapping
3. Slope Mapping
4. Transport and settlement Location mapping
5. Drainage and Surface water body Mapping
6. Watershed Classification mapping
7. Forest Classification Mapping
8. Geological mapping
9. Surveying

III Semester

Code	Paper Title	Credit	Marks		Total
			Internal Assessment	Main Exam	
GIH 301	GI Application in Water Resources	4	25	75	100
GIH 302	GI Application in Agriculture, Ecology and Forestry	4	25	75	100
GIH 303	GI Application in Earth and Atmospheric Sciences	4	25	75	100
GIS 301	GI Application in Urban Planning and Disaster Management	4	25	75	100
GIHP 301	GI Application in Water Resources	2	-	50	50
GIHP 302	GI Application in Agriculture and Forestry	2	-	50	50
GIHP 303	GI Application in Earth and Atmospheric Sciences	2	-	50	50
GISP 301	GI Application in Urban Planning and Disaster Management	2	-	50	50
	Inter Departmental Elective	2	10	40	50
		26	**110**	**540**	**650**

GIH 301: GI APPLICATION IN WATER RESOURCES

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. Methods of data collections/computation of these components.

Unit – II **16 hours**

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, Hydraulic Resistance, Leakage factor, Drainage factor

Definitions and hydrologic properties: Aquifers - Confined, Unconfined and Perched aquifers, Aquiclude, Aquifuge, Aquitard, Coastal Aquifers, Fresh and salt-water relationships in coastal and island areas.

Physico-Chemical properties of water: Methods of Interpreting water quality data,

Unit III: Management of Water Resources **16 hours**

Importance of water resources; Artificial recharge to groundwater and rainwater harvesting – surface and roof top; Management of groundwater resources; Conjunctive use of groundwater and surface water; Concepts of basin management,: Watershed characters, equation of Hydrologic equilibrium,

Groundwater Basin Investigations, water conservation techniques, Technical aspects of artificial recharge structures; Groundwater legislation.

Unit IV: Application of RS and GIS in Water Resources: 16 hours

Preparation of following Thematic Maps using RS: Drainage and their patterns, Geology and Geomorphology, Extraction of streams and watersheds maps from DEM. Floodplain mapping, Preparation of following thematic maps and their integration: Isohyetal map, groundwater contour maps, Groundwater prospects maps etc. Arc Hydro data model and tools.

References:

1. Groundwater Hydrology – 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

GIH 302: GI APPLICATION IN AGRICULTURE AND FORESTRY

Unit I: Agriculture

Introduction to Agriculture: Types of Agriculture, evolution of Indian agriculture, role of weather in agriculture, agro-climatic zones of Karnataka. Hill agriculture, Desertification and its control, crop production, cropping patterns, apiculture, farm machinery, farm management. Post-harvest Technology and Storage. Farm management. Agriculture Extension, Agricultural Legislations, Commercial crops, Sericulture in India.

Unit II: Forestry

Introduction to Forest, types of forest and their distribution, forest production, degradation of forest, factors responsible for forest degradation, deforestation-murdering the rainforest, wildlife in forest production. Manmade forest-Social forestry, agro forestry, national park, reserve forest. Economic social benefits of forest.

Unit III: GI Applications

Spectral characteristics, temporal (phonological) characteristics, leaf area index measurement, vegetation index. Crop type classification concepts, spectral response of different crops. Crop diseases and assessment, advances in crop monitoring,

Forest damage assessment and forest monitoring; Focus on Mangroves forests, forest fire mapping and monitoring.

Unit IV

Forest Modelling in GIS, Forest Change Detection Sustainable forest Management. Forest Structure Estimation,

REFERENCES:

1. A revised survey of forest types of India. Champion .H.G and Seth .S.K
2. Remote sensing of Environment, John R Jensen
3. Handbook of agriculture, Indian council of agricultural research New Delhi.
4. The Forest Production and Management-P.K.Ralhan et, al
5. Indian Forestry Science, Ahluwalia,S.K
6. Remote Sensing for Sustainable forest Management, Steven E Franklin. Lewis Publ

GIH 303: GI APPLICATION IN EARTH AND ATMOSPHERIC SCIENCES

Unit – I **16 Hours**

Spectra of Rocks and Minerals: Spectral features of Mineralogical constituents-Visible, NIR SWIR, Thermal-IR regions, Spectra of Minerals, Spectra of Rocks, VNIR and SWIR, Thermal Infrared region, Laboratory vs. Field Spectra, Spectra of other common objects.

Interpretation of Data in Thermal Region: Thermal Infrared Radiation Properties, Thermal Radiation Laws, Atmospheric Windows, Thermal Infrared Data collection, Scope for Geological Applications of Thermal Infrared Remote Sensing, Temperature Estimation by using Satellite data.

Unit - II **16 Hours**

Digital Image Processing of Multispectral Data and its scope for Geological Applications: Radiometric Image Correction, Image Enhancement, Image Filtering-High Pass Filtering (Edge Enhancement), Image smoothing, Fourier Filtering, Colour enhancement, Image Fusion, Ratioing.

Hyperspectral Sensing in Geological Applications: Spectral Characteristics, Hyperspectral sensors, Processing of Hyperspectral data, Geological Applications of hyperspectral data.

Unit - III Geological Applications **16 Hours**

Geomorphology: Tectonic, Fluvial, volcanic, coastal and Deltaic, Aeolian, Glacial Landforms. **Structure**: Bedding, folds, faults, lineaments, intrusives, unconformities.

Remote Sensing in Lithology: Sedimentary, Igneous, Metamorphic – Identification of Mineral assemblages,

Remote Sensing in Mineral Exploration: types of mineral deposits and their surface indications, Stratigraphic, Lithological, Structural guides. **Hydrocarbon Exploration**.

Unit IV: Atmospheric Remote Sensing **16 Hours**

Satellite mission- Atmospheric Chemistry, Ozone, Aerosols, Clouds, Rainfall, Weather forecasting

REFERENCE:

1. Remote Sensing Geology: By R P. Gupta, 2nd Edition, Springer Publ.
2. Imaging Spectrometry - Basic Principles and Prospective Application- Van der Meer and De Jong, Kluwer Academic publishers
3. Remote Sensing of Environment: An Earth Resources Perspective: By J.R. Jensen 2nd Ed., Upper Saddle River, NJ: Prentice Hall.
4. Image Interpretation in Geology: By S.A.Drury, Allen and Unwin

GIS 301: GI APPLICATION IN URBAN PLANNING AND DISASTER MANAGEMENT

Unit I: **16 hours**

Evolution of town planning, aim and objectives of town planning, theorigin of towns, ancient towns,moderntowns, Indian ancient towns and planning in ancient India. Principles of town planning, Land use concepts, Zoning, slums, Master plan, Building bye-laws, and public buildings. Parks and play grounds, urban road networks, Traffic management, Industries,

Unit II: **16 hors**

Resolution consideration for urban studies, Temporal and spatial characteristics of urban attributes, urban land use/land cover classification system, quality of living indicators, transport infrastructure facilities, disaster emergency response, methods of surveys in town planning, preparation of development plans,

Unit III: **16 hours**

Concepts of disaster – **Natural:** flood, landslide, Forest fire, earthquake, Volcanoes, drought and coastal disasters. **Manmade:** Water, Air, Global warming and Ozone depletion. Issues and concerns of various disasters, Disaster management, mitigation, and preparedness, Mitigation through capacity building, legislative responsibilities of disaster management:

Unit IV: **16 hours**

Disaster mapping, assessment, pre-disaster risk & vulnerability reduction, post disaster recovery & rehabilitation: disaster related infrastructure development using Remote-Sensing and GIS applications in real time disaster assessment,

monitoring, and management of Earthquakes, Volcanoes, floods, landslides, draught and coastal disasters.

REFERENCES:

1. Architecture and town planning- G.M Rajkumar – 1990
2. Urban planning, Theory and practices – M. Prathap Rao – 2005
3. Remote Sensing of the Environment an Earth Resource Perspective- J. R. Jensen – 2009
4. Town planning- Rangawala-2011
5. Introduction to Environmental Geology – Edward A Keller
6. Environmental Geology – Montgomery
7. Ecology, environment and pollution – A Balasubramanian
8. Environmental Geology – K S Valdia
9. Environmental Geology – Flawn
10. All you wanted to know about disasters – B K Khanna
11. Environmental science- A Global concern –
12. Remote sensing of Environment (An earth resource Perspective)- J R Jenson
13. Methodology for Land use planning- N.C Goutham -2001
14. Technical Guidelines for mapping- IRIS – DA NRSA-Hyderabad 2003

GIHP 301: GI APPLICATION IN WATER RESOURCES

1. Analysis of rainfall data.
2. Preparation of water level contour maps and their interpretation.
3. Calculation of Porosity, permeability, groundwater storage
4. Use of morphometric analysis in planning watershed development.
5. Analysis of DEM for delineating Flow direction, Flow Accumulation, Streams, Watersheds etc
6. Use of Model Builder for Terrain analysis
7. Groundwater potential zone demarcation by overlay analysis

GIHP 302: GI APPLICATION IN AGRICULTURE AND FORESTRY

1. Vegetation Spectral change Detection.
2. Phenological study of Crops using Temporal Data
3. Image Classification for Agricultural Crops.
4. Crop Acreage Estimation.
5. Vegetation Indices using Spatial Modeler.
   NDVI ,TNDVI,Vegetation Index, Infrared Index, MidIR Index SAVI, Kauth-Thomas Transformation
6. Change Detection of Coastal Vegetation using Spatial Modeler
7. Forest Fire Detection using Thermal data.

GIHP 303: GI APPLICATION IN EARTH AND ATMOSPHERIC SCIENCES

1. Geomorphic Pattern Recognition in Remotely Sensed Data
2. Thermal Infrared Image Interpretation
3. Spectral Enhancement**:** Image Indices and Principal Components Analysis
4. Spatial Filtering –High Pass, Low Pass Filtering, Edge Enhancement Filters
5. DEM Extraction
6. Extraction of Structural Features
7. Fourier analysis

GISP 301: GI APPLICATION IN URBAN PLANNING AND DISASTER MANAGEMENT

1. Urban sprawl studies
2. Urban classification system- Urban land use mapping
3. Urban Transport network Mapping
4. Urban land use mapping ward wise mapping
5. Sewage drainage system in urban area
6. Slums in Urban area mapping
7. Parks and Play grounds mapping
8. Solid waste management site location mapping
9. Flood Hazard Zonation Mapping
10. Landslide, Hazard Zonation Mapping
11. Drought Hazard Zonation Mapping
12. Earthquake Hazard Zonation Mapping

IV Semester

Code	Paper Title	Credit	Marks		Total
			Internal Assessment	Main Exam	
GIPW 401	Project Work	6	-	-	200
GIPV 402	VIVA	2	-	-	50
		8	**-**	**-**	**250**

ESPW 401: PROJECT WORK

Students will have to submit an individual Project Report/dissertation at the end of the IV semester. The duration of the project will be for one semester. The dissertation will be evaluated by two examiners consisting of supervisor and one external, outside the University for 4 Credits consisting of 200 marks.

ESPV 402 PROJECT VIVA VOCE

The candidate will have to defend his/her dissertation in an open viva examination for 2 credits and for 50 marks.

KUVEMPU UNIVERSITY

M.Sc. in Earth Science and Resource Management

(Choice Based Credit System) Syllabus – Revised, January 2017

Department of PG Studies and Research in Applied Geology
Jnana Sahyadri,
Shankaraghatta – 577 451

Preamble:

The Department of PG Studies and Research in Applied Geology, a nodal centre for Earth Science and Resource Management Studies (recognized by UGC under Innovative Programme), offering innovative and multidisciplinary PG and Research programs leading to M.Sc. and PhD degrees. The Department is assisted by UGC (Innovative and SAP (DRS) I, II and III) and Department of Science and Technology (FIST) programs. The Department has established well equipped mineralogy lab with polarizing microscopes, geochemical laboratory with sophisticated Atomic Absorption Spectrophotometer, Remote Sensing and GIS laboratories with High-end computers and licensed image processing and GIS software like ArcGIS, ERDAS, PCI Geomatica, ITTVIS ENVI, MapInfo along with many open source software. The department also has many digital, analog satellite images and aerial photographs needed for its academics and research. The Department has ICT enabled class rooms with multimedia facilities and a library with more than 350 text books.

As a nodal center the department strives to develop the knowledge, talent and leadership to understand the dynamic Earth and to manage its enormous resources and challenges facing the world in proper utilization of its resources.

Mission

We prepare students to understand and manage our Earth and its resources for the sustainable future.

Vision

As a nodal center recognized by UGC the department intends to be a nationally recognized through its education and research programs in Earth Science and Resource Management. The program emphasizes to produce well trained competent, academic and professional geoscientists capable of the developing new innovative technology in understanding and sustainable management of Earth and its resources.

Values

- Research at the highest international level
- Smart and attractive courses and facilities leading to appropriate competencies.
- Qualifying students for attractive positions in the public and private sectors.

Eligibility

A Bachelor's Degree in Science, Bachelor's degree with Geography at UG level, Engineering (Civil, Environmental, Mining, Geotechnical, Geoinformatics), B.Sc (Agriculture, Forestry, Horticulture, Soil Science) from any Indian university or equivalent qualification recognized by Kuvempu University. Eligibility for Foreign students will be in

accordance with the university regulations. The general admission criteria is based on Kuvempu University guidelines.

Intake

As per university rules

Course Credits

One credit means 1 hour teaching for theory and Two-hours teaching for practicum.

Duration

A two-year master's degree offered under choice-based credit system with an integrated-multidisciplinary approach. The curriculum focuses on the application based geological studies.

Attendance

A minimum of 75% attendance is required and the guidelines are as per Kuvempu University rules

Field Work

The students have to undergo a compulsory field training program up to a minimum of 7 days for which 2 credits are awarded. The students have to submit an individual field report for evaluation. The evaluation of the field report will be through viva examination.

Internship:

15 to 30 days Internship in reputed organizations/institutions based on student's choice and interest after the 2nd Semester.

Project report and viva:

Students will have to submit an individual Project Report/dissertation at the end of the IV semester which will be evaluated by internal/supervisor and external examiners. There is no financial commitment on the part of the department/University for the project work. However, the Candidates belonging to SC/ST/OBC, the provisions made by the university is applicable. The Department/University may assist the candidate in locating him/her an appropriate place to carry out the project work in reputed institutions.

The duration of the project will be for 4 months/one semester. The dissertation will be evaluated by two examiners consisting of supervisor and one external, outside the University for 4 Credits consisting of 200 marks. The candidate will have to defend his/ her dissertation in an open viva examination for 2 credits and for 50 marks.

Internal Assessment

There will be internal assessment for 25 marks for every theory paper, the assessment is based on the student's continuous evaluation consisting of Assignments, seminars, two internal tests and attendance. The internal assessment marks will be brought to the notice of students at regular interval during the course of the semester. There will be no internal assessment for practical examinations and project work.

Examination

At the end of the semester theory and practical examinations are conducted strictly as per the university guidelines. The practical examination is for 3 hours duration will have a viva for each paper.

Course Structure

Paper Code	Title of the Paper	Credit	Theory/Practical		Total
			Internal Assessment	Main Exam	
I Semester: Hard Core Papers (Theory)					
ESH 101	Crystallography, Mineralogy and Geochemistry	4	25	75	100
ESH 102	Physical Geology, Meteorology and Oceanography	4	25	75	100
ESH 103	Geoinformatics	4	25	75	100
Soft Core Paper (Theory)					
ESS 101	Digital Image Processing, Remote Sensing Applications	4	25	75	100
Hard Core Papers (Practical)					
ESHP 101	Crystallography, Mineralogy and Geochemistry	2	-	50	50
ESHP 102	Meteorology and Oceanography	2	-	50	50
ESHP 103	Geoinformatics	2	-	50	50
Soft Core Paper (Practical)					
ESSP 104	Digital Image Processing, Remote Sensing Applications	2	-	50	50
	Total	**24**	**100**	**500**	**600**
II Semester: Hard Core Papers (Theory)					
ESH 201	Igneous, Sedimentary, Metamorphic Petrology	4	25	75	100
ESH 202	Paleontology, Indian Stratigraphy, Geology of Karnataka	4	25	75	100
ESH 203	Hydrogeology, Engineering Geology	4	25	75	100
Soft Core Paper (Theory)					
ESS 201	Geomorphology, Structural Geology	4	25	75	100
Hard Core Papers (Practical)					
ESHP 202	Igneous, Sedimentary, Metamorphic Petrology	2	-	50	50
ESHP 203	Paleontology, Geostatistics	2	-	50	50
ESHP 201	Hydrogeology, Engineering Geology	2	-	50	50
Soft Core Paper (Practical)					
ESSP 201	Geomorphology, Structural Geology	2	-	50	50
	Inter Departmental Elective Paper	2	10	40	50
	Total	**26**	**110**	**540**	**650**
III Semester: Hard Core Papers (Theory)					
ESH 301	Ore Geology, Indian Mineral Deposits and Mining Geology	4	25	75	100
ESH 302	GIS Data Processing and Disaster Management	4	25	75	100
ESH 303	Exploration Geology - Geological, Geochemical and Geophysical	4	25	75	100

Soft Core Paper (Theory)					
ESS 301	Mineral and Water Resources Management	4	25	75	100
Hard Core Papers (Practical)					
ESHP 301	Ores and Ore Petrography	2	-	50	50
ESHP 302	GIS Data Processing and Disaster Management	2	-	50	50
ESHP 303	Exploration Geology	2	-	50	50
Soft Core Paper (Practical)					
ESSP 301	Hydro geochemistry and ore Reserve estimation	2	-	-	50
ESFW 101	Field Camp	2	-	50	50
	Inter Departmental Elective Paper	2	10	40	50
	Total	**28**	**110**	**540**	**700**
IV Semester					
ESPW 401	Project Work	6	-	-	200
ESPV 402	Project Viva	2	-	-	50
	Total	**08**	**-**	**-**	**250**
	Grand Total	**86**	**320**		**2200**

Inter Departmental Elective II Semester					
AGE 201	Water Resources	2	10	40	50
AGE 202	Geoinformatics	2	10	40	50
Inter Departmental Elective III Semester					
AGE 301	Natural Disaster Management	2	10	40	50
AGE 302	The World of Rocks and Minerals	2	10	40	50

SYLLABUS

M.Sc. in Earth Science and Resource Management

I Semester

ESH 101: CRYSTALLOGRAPHY, MINERALOGY AND GEOCHEMISTRY

Unit – I: Crystallography 16 hours

Crystallography - Elements of crystal structure. Symmetry elements.
X-Ray Crystallography – Principles and applications of powder X-Ray crystallography. Physical Properties of minerals, Optical Properties. Pleochroism. Double refraction. Extinction angle, birefringence and twinning in crystals. Isotropism/anisotropism, uniaxial and biaxial minerals.

Unit - II: Mineralogy **16 hours**

Introduction to mineralogy: Definition and classification of minerals. Structural and chemical principles of crystals / 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.

Unit – III: Mineralogy **16 hours**

Structure, chemistry, physical and optical characters and paragenesis of mineral groups: Feldspar, quartz, feldspathoid, aluminum silicate, epidote and garnet groups. Accessory minerals: Apatite, calcite, corundum, scapolite, sphene and zircon. Earth mineralogy: Average mineralogical composition of crust and mantle, mineral transformations in the mantle with depth.

Unit - IV: Geochemistry **16 Hours**

Introduction to Geochemistry- Elements, Atoms, and Chemical Bonds, a Brief Look at the Earth Principles of Geothermobarometry

Energy, Entropy and Fundamental Thermodynamic Concepts, Laws of Thermodynamics, laws of thermodynamics-Enthalpy, Entropy, Heat capacity and free energy concept of equilibrium and equilibrium constant

Gibbs phase rule, application to mineralogical system. Forsterite-Fayalite; Albite-Anorthite; Albite-Orthoclase. Forsterite-Quartz and Diopside-Anorthite.

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 Crystallization

Radiogenic 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

References:

1. C. Hammond, The Basics of Crystallography and Diffraction, Oxford University Press, 2009
2. Maureen M. Julian, Foundations of Crystallography, Taylor & Francis Group (2008)

3. Introduction to the Rock-forming Minerals Paperback –2013 W. A. Deer (Editor), R. A. Howie (Editor), J. Zussman (Editor)
4. Klein, C and Hurlbut, Jr., C.S. 1993; Manual of Mineralogy. John Wiley.
5. Krauskopf, K. B. and D. K. Bird. 1995. *Introduction to Geochemistry*. New York: McGraw-Hill.
6. William M. White, Geochemistry, 2013, Wiley-Blackwell

ESH 102: Physical Geology, Meteorology and Oceanography

Unit I - Physical Geology

Introduction to Physical Geology, Volcanism and Extrusive Rocks, Weathering and Soil, Time and Geology, Mass Wasting, Streams and Floods

Unit II - Physical Geology

Ground Water, Glaciers and Glaciation, Deserts and Wind Action, the Earth's Interior, Mountain Belts and the Continental Crust

Unit III- Meteorology

Fundamental principles of climatology. Earth's radiation balance; latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation, water balance. Air masses, monsoon, Jet streams, tropical cyclones, and ENSO. Classification of climates – Koppen's and Thornthwaite's scheme of classification. Climate change.

Unit IV - Oceanography

Introduction to Oceanography, Plate Tectonics, The Sea Floor, The Atmosphere and the Oceans, Circulation Patterns and Ocean Currents , Waves and Tides, Beaches, and Coasts, Estuaries, and Environmental Issues, Oceanic Environment and Production

Books for Reference:

1. Charles C. Plummer, Physical Geology Companion Site, 14/e, McGraw Hill, 2013
2. Charles E. Jones, Norris W. Jones, Lab Manual for Physical Geology, 8/e McGraw Hill,
3. Eric W. Danielson, James Levin, Elliot Abrams, Meteorology, Wm C Brown Publ.
4. Diane H. Carlson, Carlos C. Plummer, David McGeary. Physical Geology: Earth Revealed, 6/e McGraw Hill,
5. Alan P. Trujillo and Harold V. Thurman 2016 Essentials of Oceanography, Pearson Publ.

ESH 103: GEOINFORMATICS

Unit I - Aerial Remote Sensing 16 Hours

Introduction Remote Sensing: Types of Remote Sensing, Aerial Remote Sensing-Horizontal, Oblique-High oblique, low oblique. Advantages of Aerial Photography, Application of Aerial Photography

Tools in Aerial Photography: Introduction: Stereo pair, Stereoscope, Pocket Stereoscope, Mirror Stereoscope, Parallax bar, Determination of area using Planimeter, Determination of Length using Rotameter

Stereoscopic Vision Test: Determination of Relative Position of the object Carl zees stereo plate

Annotations: Introduction: Fiducial Marks, Principal Point, Conjugate Principal Point, Nadir Point, Focal Length, Vertical level, Altimeter, Date, Time, Serial photo number, Compass, Flight Altitude, Scale. **Determination of flight direction:** x-y co-ordinates, principle point, Conjugate Principal Point, Perspective center, Nadir point, flight line and direction **Determination of Scale** Average Scale

Unit II- Photogrammetry 16 Hours

Computing flying height from vertical photograph, computing relief displacement from vertical photograph, computing height of the object from vertical photograph, computing air base from vertical photograph, computing ground control point from the aerial Photograph

Principle keys for interpretation of aerial Photograph: Tone, Texture, Shape, Size, Scale, Pattern, Shadow, and Association

Application of Aerial Photograph: Fluvial landform, Coastal landform, glacial landform Structural landform, volcanic landform, Aeolian landform, Land use/ Land cover mapping.

Unit III: GIS 16 hours

Introduction, fundamentals and functions of GIS, Components of GIS.
Data and information: Types of geological and natural resources data, spatial and time variant, oriented information.
Map Projection: Earth's size and shape in time and space. Spherical coordinates, Properties of map projections, Types of basic projections classification - Cylindrical, Conical and Azimuthal projections. Overview of map projection.
Data models: Raster and Vector models. Advantages and Disadvantages of Raster and Vector Models and GIS data processing.
Data quality and errors: Importance of Errors, Accuracy and Precision, Types of Errors, Sources of Inaccuracy and Impression, Problems of Propagation and

Cascading, False precision and false accuracy, and dangers of undocumented data.

Unit IV GPS **16 hours**

GPS: GPS Overview, Global Navigation Satellite system, Fundamentals of Satellite Navigation. GPS system segments. GPS signal characteristics. GPS signal acquisition and tracking. GPS-Error sources, Measurements, Accuracy and estimates of user position and time.

References

1. Photogrammetry- Moffit, H.F., and Edward, M.M., (1980). Harper and Row Publishers
2. Fundamentals of Remote Sensing and Air Photo Interpretation, Avery T.E. and G.L.Berlin, Prentice Hall (1992)
3. Manual of Photogrammetry, 3rd Edition,1966, American Society of Photogrammetry
4. Aerial Photographs in Geologic Interpretation and Mapping By RICHARD G. RAY
5. Photogrammetry by Richard Burns, PLS Caltrans Geometronics.
6. Geographic Information Systems and Science 3rd Edition **by** Paul A. Longley, Mike Goodchild, David J. Maguire, David W. Rhind, John Wiley and Sons
7. Concepts and Techniques of Geographic Information Systems, 2nd Edition Chor Pang Lo, Albert K.W. Yeung, Prentice Hall Publ.

ESS 101: DIGITAL IMAGE PROCESSING, REMOTE SENSING APPLICATIONS

Unit-I: Digital Image Processing **16 hours**

Data collection, data analysis, data collection errors, Remote sensing data requirements, image processing functions, image data formats. **3 Hours**

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. **4 Hours**

Image Rectification and Restoration: Geometric correction, geometric errors, types of geometric corrections: Image to map, Image to Image, hybrid approach, rectification logic, Mosaicking. **4 Hours**

Image enhancement: Image reduction and magnification, contrast enhancement-linear and nonlinear enhancements, Band ratioing, spatial filtering- spatial convolution filtering, Fourier transformation, principal component analysis. **5 Hours**

Unit-II: Digital Image Processing **16 hours**

Thematic Information extraction: Supervised classification – Landuse and Landcover classification schemes. Training site selection and statistical extraction. Feature selection of classification algorithm. Unsupervised classification methods-Chain and ISODATA methods, cluster busting, Fuzzy classification. Object oriented Classification. **6 Hours**

Thematic information Extraction-Hyperspectral Image Analysis: Hyperspectral data collection, Steps to extract information from Hyperspectral data, Hyperspectral Image quality assessment, Radiometric calibration, MNF (Minimum Noise Fraction, Pixel purity index mapping, Spectral Angle Mapper, Indices from Hyperspectral Data

6 Hours

Thematic map accuracy: Landuse/Landcover 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.

4 Hours

Unit III: Remote Sensing Applications **16 Hours**

Thermal Infrared Remote Sensing: Thermal Infrared Radiation Properties, Thermal Radiation Laws, Atmospheric Windows, Thermal Infrared Data collection, Thermal Infrared Remote Sensing**.** **4 Hours**

Active and Passive Microwave Remote Sensing: Active Microwave system components, RADAR environmental considerations, SAR Remote Sensing, RADAR Interferometry, and Passive Microwave Remote Sensing. **3 Hours**

LIDAR Remote Sensing: LIDAR Principles, Accuracy of LIDAR Measurements, LIDAR derived vegetation information LIDAR derived Urban Information. **3 Hours**

Remote Sensing of Vegetation: Spectral Characteristics of Vegetation, Temporal Characteristics of Vegetation **Indices**: Vegetation Indices, Remote Sensing of Vegetation change. **6 Hours**

Unit IV: Remote Sensing Applications **16 Hours**

Remote Sensing of Urban Landscape: Urban/suburban resolution considerations, Remote Sensing Land use and Land cover, Residential Land use, Commercial Land use, Industrial land use, Transportation infrastructure, Communication and Utilities, Urban Disaster Emergency Response.
6 Hours

Remote Sensing in Geology: Remote Sensing of Soils, Remote Sensing of Rocks and Minerals; Imaging Spectroscopy of Rocks and Minerals. Lithology, Structure, Drainage and pattern, Remote Sensing in Geomorphology; Landforms; Igneous, sedimentary, structural, fluvial, karst, shoreline, Aeolian and Glacial. **6 Hours**

Remote Sensing of Water: Remote Sensing of Surface water Biophysical Characteristics, Spectral Responses of Water as a function of Wavelength and organic/inorganic constituents, Water Bathymetry, Water surface temperature, Precipitation, Aerosols and clouds, Snow, Water quality modeling using Remote Sensing. Watershed analysis **4 Hours**

Books for Reference

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).

I SEMESTER PRACTICAL

ESHP 101 CRYSTALLOGRAPHY, MINERALOGY AND GEOCHEMISTRY

1. Study of models of cubic, tetragonal, hexagonal, orthorhombic, monoclinic and triclinic systems
2. Stereographic projections on the Wulff's Stereo net.
3. Megascopic study of rock forming minerals
4. Determination of relative relief (RI) of minerals by Becke-line test and sign of elongation of minerals.
5. Optical properties of Rock forming minerals
6. Microscopy of rock forming minerals
7. Determination of optic sign of uniaxial minerals, optic sign of biaxial minerals.
8. Determination of anorthite content of plagioclase by Michel Levy Method.

ESHP 102 METEOROLOGY AND OCEANOGRAPHY

1. TRMM Rainfall data Analysis- Monthly trends, Deviation from Normal Rainfall, Statistical Analysis
2. Estimation of Spatial and Temporal Variability of Rainfall
3. Interpretation of Weather maps and weather forecasting
4. Numerical Weather Prediction
5.

ESHP 103 GEOINFORMATICS

Introduction Remote Sensing

Types of Remote Sensing,
Aerial Remote Sensing-Horizontal, Oblique-High oblique, low oblique
Advantages of Aerial Photography,
Application of Aerial Photography

Tools in Aerial Photography:

Introduction: Stereo pair, Stereoscope, Pocket Stereoscope, Mirror Stereoscope, and Parallax bar, Determination of area using Planimeter, Determination of Length using Rotameter

Stereoscopic Vision Test:

Determination of Relative Position of the object Carl zees stereo plate

Annotations

Introduction: Fiducial Marks, Principal Point, Conjugate Principal Point, Nadir Point, Focal Length, Vertical level, Altimeter, Date, Time, Serial photo number, Compass, Flight Altitude, Scale. **Determination of flight direction:** x-y co-ordinates, principle point, Conjugate Principal Point, Perspective center, Nadir point, flight line and direction

Determination of Scale Average Scale

Photogrammetry

Computing flying height, relief displacement, height of the object, air base, ground control point from vertical photograph

Principle keys for interpretation of aerial Photograph

a. Tone, b. Texture, c. Shape, d. Size, e. Scale, f. Pattern, g. Shadow, and h. Association

Application of Aerial Photograph: Fluvial landform, Coastal landform, glacial landform Structural landform, volcanic landform, Aeolian landform, Land use/ Land cover mapping

ESSP 101 DIGITAL IMAGE PROCESSING, REMOTE SENSING APPLICATIONS

1. Introduction to Imagine Software and Image Data
2. Image Enhancement
3. Rectification
4. Image Classification – Unsupervised
5. Image Classification – Supervised
6. Object Based image analysis
7. Radiometric Correction (Empirical Line Calibration)
8. Image operation and Image fusion
9. Accuracy Assessment
10. Vegetation indices
11. Watershed analysis

II SEMESTER

ESH 201 IGNEOUS, SEDIMENTARY, METAMORPHIC PETROLOGY

Unit – I **16 hours**

Introduction: Definition and classification of rocks based on mode of formation.

Igneous Rocks: Magma and its origin, formation of igneous rocks. Bowen's reaction principle. Crystallization of binary systems. Forms, Textures and structures of igneous rocks. Classification of igneous rocks.

Magmatic evolution and differentiation: Fractional crystallization, gravitational differentiation, gas streaming, liquid immiscibility and assimilation. Structures and textures: Definition, description, rock examples and genetic implications of common structures and textures of igneous rocks. Classification of igneous rocks: Mode, CIPW norm, IUGS and Irvine-Barger classifications; Magmatism and tectonics:

Unit – II **16 hours**

Igneous rock suites: Form, structure, texture, modal mineralogy, petrogenesis and distribution of the following igneous rocks: Ultramafic rocks: Dunite-peridotite-pyroxenite suite; kimberlites, lamprophyres, lamproites, komatiites; Basic rocks: Gabbro-norite-anorthosite-troctolite suite, Dolerites; Basalts and related rocks; Intermediate rocks: Diorite-monzonite-syenite suite; Andesites and related rocks; Acidic rocks: Granite-syenite-granodiorite-tonalite suite; Rhyolites and related rocks; Alkaline rocks: Shonkinite, ijolite, urtite, melteigite, malignite, alkali gabbros, alkali basalt, alkali granite, alkali syenite, nepheline syenite and phonolite; Carbonatites; Ophiolite suite.

Unit–III **16 hours**

Sedimentary rocks: 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–IV **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.

Books for Reference

1. Igneous And Metamorphic Petrology – Turner and Verhoogan
2. Text book of Petrology – G W Tyrrell
3. Petrology – Hyndman
4. Igneous and Metamorphic Petrology – Myren G Best
5. Petrology (Igneous, Sedimentary and Metamorphic) – Eenest G Ehlers/Harvey Blatt
6. Igneous Petrology- McBirney
7. Principles of Igneous and Metamorphic Petrology- Anthoney R Phillpots
8. Igneous Petrology – M K Bose
9. Petrology of Igneous rocks – Alokh K Gupta
10. Metamorphism and Metamorphic rocks – Miyashro
11. Metamorphic Petrology – B Bhaskar Rao
12. Sedimentary Petrology – Pettijohn
13. Igneous and Metamorphic Petrology – W D Winter
14. Petrology (Igneous, Sedimentary and Metamorphic) – Loren A Raymond

ESH 202: PALEONTOLOGY, INDIAN STRATIGRAPHY, GEOLOGY OF KARNATAKA

Unit I: PALEONTOLOGY **16 hours**

Introduction: Classification of life plant kingdom and Animal kingdom-vertebrate and invertebrate –phylum, class, order, general and species.

Fossils: Mode of preservation of fossils. Morphology and Geological distribution of Foraminifera, Brachiopods, Lamellibranch, Gastropods, Cephalopods, Echinoids & Trilobites.

Plant fossils-Morphology and distribution of Lepidodendron, sigillaria, calamities, Glossopteris, ptilophyllum.

Unit – II: INDIAN STRATIGRAPHY **16 hours**

Principles of stratigraphy, Geological time scale, Lithostratgraphic 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.

Unit – III: INDIAN STRATIGRAPHY **16 hours**

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: GEOLOGY OF KARNATAKA **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 Basins-Kaladgi and Bhima group, Gondwana group, Deccan volcanism, Dykes rocks. Tertiary rocks laterite and Black soil.

REFERENCES:

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,
10. H.Woods, Cambridge University press, 1961
11. 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

12. B.U.Haq and A.Boerma, 1978, Introduction to Marine Micropaleontology, Elsvier Publishing Company. M.D., Brasier, 1980, Microfossils, George Allen & Unwin, London.
13. G.Bigot, 1985, Elements of Micropaleontology, Grahm & Trotman, London.
14. H.H.Swinerton, (1961) Outlines of Paleontology, Edward Arnold PublisherReference Books
15. Derek V.Ager, 1963, Principles of Paleoecology, McGraw Hill Book Co.Benton, M.J. 1990, Vertebrate Paleontology, John Wiley,
16. Unwin Hyman, , 1971, Vertebrate Paleozoology, John Wiley,
17. F.B.Phleger, Ecology and Distribution of Recent, Foraminifera, Hohn Hopkins Press.
18. J.P.Kennet and M.S.Srinivasan; 1951, Forminifera, W.H.Freeman & Co.,

ESH 203 HYDROGEOLOGY, ENGINEERING 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.

Unit – II **16 hours**

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 – III **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 IV: Engineering Geology **16 hours**

Role of engineering geology in civil construction and mining industry. Engineering properties of rocks; rock discontinuities. Physical characters of building stones. Metal and concrete aggregates. Various stages of engineering geological investigation for civil engineering projects.
Geological consideration for evaluation of dams and reservoir sites. Dam foundation rock problems. Geotechnical evaluation of tunnel alignments and transportation routes, method of tunneling; classification of ground for tunneling purposes; various types of support.
Earthquake and seismicity, seismic zones of India, design of buildings in earthquake zones.

Books of 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.

Soft Core Paper (Theory)

ESS 201 GEOMORPHOLOGY, STRUCTURAL GEOLOGY

UNIT – I **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 .

Unit – II **16 Hours**

Mass wasting: Classifications, Causes geomorphic significance and conservation of mass wasting,
Morphology of Indian sub-continent
Morphology of the ocean floor.
Applied Geomorphology: Dams and Reservoirs, tunnels, and High way construction,
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 – III: ROCK DEFORMATION **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: STRUCTURES **16 hours**

Definition and importance of structural Geology. Primary and Secondary Structures, 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.

Practical II Semester

ESHP 201 Igneous, Sedimentary, Metamorphic Petrology

1. Study of megascopic structures

2. Megascopic study of Igneous rocks ;Granite-Granodiorite-Diorite, Syenites, Ultramafic rocks, lamrophyres, dolerites, pegmatites and Basalts
3. Megascopic study of sedimentary rocks-rudaceous, arenaceous, calcareous and argillaceous rocks
4. Megascopic study of metamorphic rocks;-Schists, gneisses, amphibolites and granulites
5. CIPW calculations, Variation diagrams, Binary-ternary diagrams,
6. PT estimation, Thermogeobarometry calculations

ESHP 202 Paleontology, Geostatistics

1. **Identification of invertebrate fossils-** Brachiopods, Lamellibranch, Gastropods, Cephalopods, Echinoids & Trilobites.
2. **Plant fossils**-Morphology and distribution of Lepidodendron, sigillaria, calamities, Glossopteris, ptilophyllum.
3. Identification of Microfossils: Foraminifera, Ostracod,
4. Central tendency, mean, median, mode, standard deviation, correlation, Principle component analysis.

ESHP 203 Hydrogeology, Engineering Geology

1. Analysis of rainfall data
2. Calculation of Evapotranspiration by different methods
3. Preparation of water level contour maps and their interpretation
4. Calculation of Porosity, permeability, and groundwater storage
5. Water budget calculations
6. Pumping test data analysis
7. Groundwater flow direction calculation
8. Interpretation of geological maps for construction of roads, tunnels, bridges, reservoir sites etc.

ESSP 201 Geomorphology, Structural Geology

1. Preparation of Geomorphology map and Symbols used in Geomorphology map
2. Toposheet Reading
3. Preparation of drainage map, Calculation of Morphometry parameters Preparation of Spatial map of drainage density, drainage Frequency, Relative Relief, Dissection Index, Spatial map of Slope map,
4. Meandering and Sinuosity Index
5. Exercises on structural geology problems – thickness of beds on horizontal, inclined surfaces.
6. Exercises on structural geology problems – Dip and strike problems
7. Exercises on structural geology problems – Borehole problems

8. Stereographic projections of structural data.
9. Drawing and interpretation of profile section across the geological maps.
10. Site selection for construction of Dams, Tunnels, Highways, Roads, Reservoirs and Canals.
11. Completion of out crops maps
12. Field observations and measurement of primary and secondary structures
13. Use of compass clinometers

Inter Departmental Elective

AGE 201 Water Resources

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. Methods of measurements and instruments. Description of surface water resources including ponds, lakes, streams, rivers and reservoirs. Global water budget. Artificial recharge of water and Rainwater harvesting.

Unit – II **16 hours**

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, Hydraulic Resistance, Leakage factor, Drainage factor

Definitions and hydrologic properties: Aquifers - Confined, Unconfined and Perched aquifers, Aquiclude, Aquifuge, Aquitard, Coastal Aquifers, Fresh and salt-water relationships in coastal and island areas.

AGE 202 Geoinformatics

III Semester

ESH 301 ORE GEOLOGY, INDIAN MINERAL DEPOSITS AND MINING GEOLOGY

Unit I **16 Hours**

Modern concept of ore genesis. Ore deposits and Plate Tectonics. Mode of occurrence of ore bodies-morphology and relationship of host rocks. Textures, paragenesis and zoning of ores and their significance. Ore bearing fluids, their origin and migration. Wall-rock alteration. Structural, physico-chemical and stratigraphic controls of ore localization. Fluid inclusion in ores: Principles, assumptions, limitations and applications. Geothermometry of ore deposits.

Unit II **16 Hours**

Ores of mafic-ultramafic association- diamonds in kimberlite; Ti-V ores; chromite and PGE; Ni ores; Cu, Pb-Zn. Ores of silicic igneous rocks with special reference to disseminated and stock work deposits, porphyry associations. Ores of sedimentary affiliation-chemical and clastic sedimentation, stratiform and stratabound ore deposits (Mn, Fe, non-ferrous ores), placers and palaeoplacers. Ores of metamorphic affiliations-metamorphism of ores, Ores related to weathering and weathered surfaces laterite, bauxite, Ni/Au laterite.

Unit III **16 Hours**

Mineralogy, Origin , Occurrence and Distribution of mineral deposits; Gold, Copper, Iron, Manganese, Chromium, Aluminum, Uranium, Lead and Zinc, Industrial Minerals- abrasives, ceramics, refractory's, insulators. Coal and Petroleum.

Unit IV **16 Hours**

Application of rock mechanics in mining. Planning, exploration and exploratory mining of surface and underground mineral deposits involving diamond drilling, shaft sinking, drifting, cross cutting, winzing, stoping, room and pillaring, top-slicing, sub-level caving and block caving. Cycles of surface and underground mining operations. Exploration for placer deposits. Open pit mining. Ocean bottom mining. Mine ventilation, Types of drilling methods. Mining hazards: mine inundation, fire and rock burst.

Books

1. Craig, J.M. & Vaughan, D.J., 1981: Ore Petrography and Mineralogy-John wiley

2. Evans, A.M., 1993: Ore Geology and Industrial Minerals-Blackwell
3. Sawkins, F.J., 1984: Metal deposits in relation to plate tectonics-Springer Verlag
4. Stanton, R.L., 1972: Ore Petrography-McGraw Hill
5. Torling, D.H., 1981: Economic Geology and Geotectonics-blackwell Sci publ.
6. Barnes, H.L., 1979: Geochemistry of Hydrothermal Ore Deposits-John Wiley
7. Klemm, D.D. and Schneider, H.J., 1977: Time and Strata Bound Ore Deposits-Springer Verlag
8. Guibert, J.M. and Park, Jr. C.F., 1986: The Geology of Ore Deposits-Freeman
9. 9.Mookherjee, A., 2000: Ore genesis-a Holistic Approach-Allied Publisher
10. Arogyaswami, R.P.N., 1996: Courses in Mining Geology.IV Ed.-Oxford IBH

ESH 302 GIS Data Processing and Disaster Management

Unit–I: 16 hours

Introduction, significance of spatial Analysis, Vector Based - Various types of overlay analysis operations: Topological overlays, Polygon-in-polygon overlay, line-in-polygon overlay, Point-in-polygon overlay, Logical operations (Boolean operations), Conditional operations, Buffer analysis, Site suitability analysis.

Unit–II: 16 hours

Raster Based - Introduction, Advantages and disadvantages of raster analysis, Grid operations used in map algebra, important raster analysis operations, Grid based spatial analysis – Neighborhood analysis

Conditional, Density, Distance, interpolation, Map algebra, Overlay – weighted overlay, reclassification, surface analysis – aspect, contour, hillshade, slope etc., Network analysis, Connectivity rules, Utility Networks, Transportation Networks, Geometric network, Logical Network, Network based model, Applications of network analysis

Unit III: 16 hours

Concepts of disaster: **Natural:** Cyclone, flood, landslide,. Forest fire and earthquake. Issues and concern for various causes of disasters. **Manmade:** Fundamental Concepts of Environment. Air, Water, Land, and Noise pollution - Types, sources and causes of pollution. Effect of pollution on ecology and environment. Global warming, Ozone depletion. Types of wastes and their management. Hazard assessment, monitoring, and management of Earthquakes, Volcanoes, floods, landslides, subsidence, draught and Coastal hazards.

Unit IV: 16 hours

Disaster management, **mitigation, and preparedness:**, Mitigation through capacity building, legislative responsibilities of disaster management: disaster mapping, assessment, pre-disaster risk & vulnerability reduction, post disaster recovery & rehabilitation: disaster related infrastructure development. Remote-Sensing and GIS applications in real time disaster assessment, monitoring, and prevention of Earthquakes, Volcanoes, floods, landslides, subsidence, draught, hurricanes, cyclones, tsunamis.

REFERENCES:

1. Introduction to Environmental Geology – Edward A Keller
2. Environmental Geology – Montgomery
3. Ecology, environment and pollution – A Balasubramanian
4. Environmental Geology – K S Valdia
5. Environmental Geology – Flawn
6. All you wanted to know about disasters – B K Khanna
7. Environmental science- A Global concern –
8. Remote sensing of Environment (An earth resource Perspective)- J R Jenson
9. Methodology for Land use planning- N.C Goutham Centre for land use management Hyderabad- 2001
10. Technical Guidelines for mapping- IRIS – DA NRSA-Hyderabad 2003
11. Rajiv Gandhi National drinking water mission –technical guidelines for preparation of ground water prospect map NRSA-Hyderabad 2003
12. Integrated Mission for Sustainable Development- Technical Guide lines NRSC-Hyderabad 1995

ESH 303 EXPLORATION GEOLOGY - GEOLOGICAL, GEOCHEMICAL AND GEOPHYSICAL

Unit – I **16 hours**

Geological and Geomorphological Exploration: Geological and geomorphological criteria for mineral and ground water prospecting. Indicators of ore. Methods of geological exploration and prospecting. Drilling and core logging. Preparation of technical report.

Unit – II **16 hours**

Geochemical Exploration: Basic principles-geochemical dispersion, geochemical mobility, geochemical reaction, and dispersion of elements under deep-seated conditions, mobility under surfacial conditions. Association of elements. Patterns of geochemical distribution. Patterns of deep-seated origin-ore type, geochemical provinces. Epigenetic anomalies in bed rocks. Mechanical and biological dispersion in sulphide environments. Surfacial dispersion patterns. Anomalies in

overburdens, natural water and drainage sediments. Geochemical drainage surveys. Vegetation surveys. Geochemical methods in mineral exploration.

Unit - III **16 hours**

Geophysical Exploration: Magnetic methods- fundamental principles, magnetic surveying techniques, magnetic data interpretation. Gravity method- Principles, instruments, field measurements and interpretation. Seismic method – General principles. Seismic reflection methods-recording instruments, field procedures, data acquiring and interpretation. Principles of Seismic refraction method.

Unit IV **16 Hours**

Electrical method – Introduction, principles, instruments, field procedures, interpretation and application. Radioactive method – Introduction, radioactive decay, instruments, field procedures and applications and interpretation of data. Well logging methods – Classification and interpretation

ESS 301 Mineral and Water Resources Management

Unit – I **16 hours**

Introduction: Principles of economics. Significance of resources in national economy. Resource scenario of India. Production, demand, supply and substitution of natural resources in global contest.
Mineral Resources: Commercial grade and specification of minerals. Production and pricing of mineral in national and international market. India's mineral policy – strategic, critical and essential mineral policy. Structure and organization of mineral industries. Role and scope of Govt., Pvt., and Public enterprises in mineral resources development and management. Safety and environmental protection.

Unit – II **16 hours**

Mineral Conservation: Introduction, Growth and awareness. Methods of conservation. Limitations in the scope of conservation
Mineral Processing: Principles of mineral processing,
Physical methods: Separation by grain size, gravity and magnetism
Chemical Methods: Flotation and flow sheets

Unit – III **16 hours**

Groundwater Provinces of India: Tayler, Chaterjee and Handa's Classifications.
Water Resources Assessment: Elements of Water Balance, evaluation of water balance, India's Groundwater budget etc.

Water Quality: Physical and chemical properties of water, Classification of water for Domestic, Irrigation and Industrial purposes based on physical, chemical and biological properties. Methods of interpretation of chemical data and Hydro chemical facies.

Groundwater Development and Management: Groundwater development, Water Logging, Conjunctive use, Desalination, Groundwater Legislation.

Unit – IIV **16 Hours**

Management of Water Resources: Concepts of basin management, equation of Hydrologic equilibrium, Groundwater Basin Investigations, Data Collection and Field Work, Alternative Basin yield, Evaluation of Perennial yield, Salt Balance, Basin Management by Conjunctive Use

Water Conservation Techniques/Practices, Rain Water Harvesting: Surface and Roof top, Drought Monitoring: Forecasting and Management, Flood Monitoring: Forecasting and Management.

REFERENCES:

1. Mining Geology – P Arogya swamy
2. Elements of Mining Geology – Young
3. Mineral processing – S K Jain
4. Principles of Mineral dressing – A M Gaudin
5. Principles of Geoinformatics – R.K Gupta & Subhash Chander
6. Publication. Jain Brothers- 2005
7. Surveying and Levelling – T.P Kanetkar & S.V kulkarni
8. Publications Vidyarthi Griha prakasan Pune- 1984
9. Groundwater Hydrology (2nd Ed.) – D.K.Todd – John Wiley and Sons Inc. New York.
10. Hydrogeology (2nd ed.) – C.W.Fetter – Merrill Publishing Co. U.S.A.
11. Hydrogeology - K.R.Karanth – Tata McGraw Hill Publishing Co. Ltd.
12. Ground Water Assessment, Development and Management – K.R.Karanth– Tata McGraw Hill Publishing Co. Ltd.
13. Groundwater – H.M.Raghunath – Wiley Eastern Limited
14. Hydrology – H.M.Raghunath– Wiley Eastern Limited
15. Elements of Hydrology – V.P.Singh
16. Engineering Hydrology – K.Subramaniam - Tata McGraw Hill Publishing Co Ltd.
17. Applied Hydrology – Mutreja, K.N. - Tata McGraw Hill Publishing Co. Ltd.

Hard Core Papers (Practical)

ESHP 301 Ores and Ore Petrography

1. Megascopic study of common metallic minerals.

2. Megascopic study of industrial minerals and rocks
3. Reflected-Microscope and its application.
4. Study of the Metallic mineral properties viz.; reflectivity, colour, birefringence and isotropism & anisotropism. Internal reflection and Micro indentation hardness.

ESHP 302 GIS Data Processing and Disaster Management

1. Spatial data query – based on attributes
2. Spatial query – based on location
3. Spatial data query - based on condition, Boolean operation, multiple query.
4. Spatial data query - Location suiable site based on attributes and location.
5. Spatial data query – raster data – mathematical operations, logical conditions, Boolean operations.
6. Topological overlay analysis – Vector data
7. Overlay analysis – Raster data
8. Neighborhood analysis
9. Network analysis
10. Flood prone area mapping
11. Landslide prone area mapping
12. Earthquake prone area mapping
13. Drought Prone area mapping

ESHP 303 Exploration Geology

SAA

Soft Core Paper (Practical)

ESSP 301 Hydro geochemistry and ore Reserve estimation

ESFW 101 Field Camp

The students have to undergo a compulsory field training program up to a minimum of 7 days. The students have to submit an individual field report for evaluation. The evaluation of the field report will be through viva examination.

Inter Departmental Elective

AGE 301 Natural Disaster Management

AGE 302 The World of Rocks and Minerals

IV Semester

ESPW 401 Project Work

Students will have to submit an individual Project Report/dissertation at the end of the IV semester which will be evaluated by internal/supervisor and external examiners. The duration of the project will be for 4 months/one semester. The dissertation will be evaluated by two examiners consisting of supervisor and one external, outside the University for 4 Credits consisting of 200 marks.

ESPV 402 Project Viva

The candidate will have to defend his/her dissertation in an open viva examination for 2 credits and for 50 marks.