Annexure-II

CENTRAL UNIVERSITY OF KARNATAKA

Curriculum

for

MSc Applied Geology

Based on
Learning Outcomes based Curriculum Framework (LOCF)

Revised in April, 2021, effective from 2021-22 AY

Department of Geology
School of Earth Sciences
Central University of Karnataka
Kalaburagi, Karnataka

Department of Geology

MSc in Applied Geology Syllabus

Learning Outcomes based Curriculum Framework (LOCF)

Part A: About MSc in Applied Geology Programme

I. Preamble:

Geology is the study of the Earth, the materials of which it is made, the structure of those materials, and the processes acting upon them. An important part of geology is the study of how Earth‟s materials, structures, processes and organisms have changed over time. Geology can also refer generally to the study of the solid features of any celestial body (such as the geology of the Moon or Mars).

The Central University of Karnataka offers MSc course in Applied Geology to reduce the disparity between the need and availability of competent professionals to cater the requirements of our nation. This programme is basically an academic programme which focuses on preparing the students for research, as well as, for application of geological knowledge in various field settings.

II. Vision Statement:

To emerge as a centre of excellence in the field of Geology in teaching, learning, research, training, practicing and producing human resources of very high standard.

Geology is the study of the Earth, the materials of which it is made, the structure of those materials, and the processes acting upon them.

III. Mission Statements:

MS1. To produce human resources of greater competence and employable skills in Geology at all levels of programmes

MS 2. To contribute to the existing knowledge bank in geological sciences with an integrated and interdisciplinary approach.

MS 3. To collaborate with the premier institutions in India and abroad in order to achieve excellence in both teaching and research

MS 4. To develop in-depth knowledge and skills in qualitative and quantitative research methods through laboratory, field and web modes of learning.

IV. Qualification Descriptors (QDs)

Once Master program in M.Sc. in Applied Geology is completed, the students will be able to

QD1: Demonstrate comprehensive knowledge in areas of Geology, and its various field of applications.
QD2: Use tools, equipment and techniques required for collecting field data and to analyse them for scientific results.
QD3: To obtain the exposure to understand the emerging concepts of the earth system sciences and to do high level of research with leading theoretical and laboratory techniques which are essential to subsidize to acquaintance in research field.
QD4: Acquire knowledge and skills to solve the applied aspects of geological sciences.
QD5: Should be able to proficiently communicate geological concept, ideas and research.

Mapping Qualification Descriptors (QDs) with Mission Statements (MS)

	MS-1	MS-2	MS-3	MS-4
QD:1	3	2	2	1
QD:2	2	3	1	2
QD:3	3	2	3	1
QD:4	3	2	2	3
QD:5	3	2	3	2

Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

M.Sc. in Applied Geology

V. Program Learning Outcomes (PLOs)

After completion of this academic program, the students will be able to

PLO-1: Demonstrate the ability to identify the geological features in the field.

PLO-2: To develop skills of analysis, collective thinking and synthesis the data through geoscientific method.

PLO-3: To solve the geologic problems using the available or collected data from all disciplines of Geology.

PLO-4: To comprehend the relation between society and Earth.

PLO-5: To become a perfect Geoscientist and able to carry out research as an individual or as team.

PLO-6: Demonstrate the ability to identify ethical issues related to one's work, avoid unethical behaviour such as fabrication or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, appreciate environmental and sustainability issues, and adopt objective, unbiased and truthful actions in all aspects of work.

PLO-7: Demonstrate the ability to acquire knowledge and skills necessary for learning throughout life, through self-paced and self-directed learning aimed at personal development and meeting the changing trades and demands of work place.

Mapping of Program Learning Outcomes (PLOs) with Qualification Descriptors (QDs)

	QD-1	QD-2	QD-3	QD-4	QD-5
PLO-1	3	2	3	3	1
PLO-2	3	2	3	3	3
PLO-3	2	3	1	2	2
PLO-4	2	3	2	3	3
PLO-5	1	2	1	2	3
PLO-6	2	3	2	3	3
PLO-7	2	3	2	3	3

Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

VI. Other Information

1. **Name of the Course:** M.Sc. Applied Geology (Department of Geology; under School of Earth Sciences)
2. **Duration of the Course**: Two years (Four semesters)
3. **Eligibility and Attendance**: As per University rules.
4. **Intake:** As per University norms
5. **Medium of Instruction and examination**: English
6. **Miscellaneous**: All other matters not referred to specifically shall be governed as per the Ordinances of the University as revised from time to time.
7. **Course structure and credit allocation**: Each credit denotes 1hour for theory and two-hours for practicum. Total credits of the programme: 86

Part B. SCHEME OF STUDY

Programme Code: PGGEL
Master of Science in Geology

Scheme of Study and examinations
(L= Lecture, T= Tutorial, P = Practical)

	SEMESTER - I					
	Code	Subject	Credits	L	T	P
Core Course Paper-1	PGETC12001	Mineral Science and Geochemistry	4	4		
Core Course Paper-2	PGETC12002	Stratigraphy and Palaeontology	4	4		
Core Course Paper-3	PGETC12003	Geomorphology and Structural Geology	4	4		
Core Course Practical Paper-1	PGEPC12004	Practical: Mineral Science & Palaeontology	2			2
Core Course Practical Paper-2	PGEPC12005	Practical: Geomorphology and Structural Geology	2			2
Skill Enhancement Course -1 (Foundation Course – Man-making)	PGEFS12101	Field work	2			2
Ability Enhancement Compulsory Courses 1 (Foundation Compulsory)	PGETA12102	Basics of Geoinformatics	3	2	1	
Generic Elective Courses Paper-1	PGETG12301	Earth Resources / Fossils and Their Applications	3	2	1	
		Total	**24**			

	SEMESTER - II					
	Code	Subject	Credits	L	T	P
Core Course Paper-4	PGETC22006	Igneous, Sedimentary and Metamorphic Petrology	4	4		

Core Course Paper-5	PGETC22007	Climatology	3	2	1	
Core Course Paper-6	PGETC22008	Hydrogeology and Environmental Geology	3	3		
Core Course Practical Paper-3	PGEPC22009	Practical: Petrology	2			2
Core Course Practical Paper -4	PGEPC22010	Practical: Hydrogeology, Environmental Geology, and DIP	2			2
Ability Enhancement Compulsory Course 2 (Foundation-Compulsory)	PGETA22103	Digital Image Processing (DIP)	3	3		
Skill Enhancement Course 2 (Foundation Course-Man making)	PGETS22104	Social Orientation Course	2	1	1	
Generic Elective Courses Paper-2	PGETG22302	Hazards, Disaster Mitigation and Management/ Introduction to Earth Surface Processes	3	2	1	
		Total	**22**			

	SEMESTER – III					
	Code	Subject	Credits	L	T	P
Core Course Paper-7	PGETC32011	Ore Geology and Mining Geology	4	4		
Core Course Paper-8	PGETC32012	Exploration Geology	3	3		
Core Course Paper - 9	PGETC32013	Advanced GIS Techniques	3	3		
Core Course Practical Paper-5	PGEPC32014	Practical: Exploration Geology, Engineering Geology, and Ore Petrology	2			2
Core Course Practical Paper - 6	PGEPC32015	Practical: GIS, Cartography and Surveying	2			2
Discipline Specific Elective :1	PGETD32201	Advanced Remote sensing in Geological sciences	3	2	1	
Ability Enhancement Compulsory Course 3 (Foundation-Compulsory)	PGETA32105	Engineering Geology, Geodesy and Surveying	3	2	1	
		Total	**20**			

	SEMESTER – IV					
	Code	Subject	Credits	L	T	P
Core Course Paper-10	PGEIC42016	Internship	8			8
Discipline Specific Elective 2	PGERD42202	Major Project and Dissertation	12			12
		Total	**20**			
		Grand Total	**86**			

Semester I

PGETC12001–Mineral Science and Geochemistry

(4 credits = 4 hrs/week; 1 credit = 15 hrs/semester. So, 4 credits = 60 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO 1: Explain systematic descriptions and identifications of minerals in rocks

CLO 2: Explain the images of thin sections viewed under a polarising microscope

CLO 3: Describe how and in what environments the minerals and rocks were formed

CLO 4: Explain the chemical characteristics of the universe

CLO 5: Describe the geochemistry of water and sediments

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	3	3	3	2	3
CLO2	2	3	3	2	3
CLO3	3	2	3	3	3
CLO4	3	1	2	3	2
CLO5	3	3	2	3	3

Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

(ii) Broad contents of the course:

This course covers topics related to symmetry operations, characteristics of different mineral groups, analytical techniques related to mineral study, isotopes, sediment and water geochemistry.

(iii) Skills to be learnt:

Students will acquire skills related to recognition of a variety of minerals, characteristics of silicate structures, understanding the rock-forming mineral thin sections using a polarising microscope, classification of geochemistry, trace elements and REE.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(15 hours)

Crystallography and Mineral Chemistry: Periodicity and symmetry-concept of space lattice. Introduction to aspects of crystal structure – Hexagonal close packing, Cubic close packing. Pauling's rules. Solid solutions – substitutional solid solution, Coupled Substitution, Interstitial solid solution, Omission solid solution. Defects in

minerals- point defects, line defects, and planar defects. Applications of XRD, SEM, EPMA in mineralogy.

Unit II: (15 hours)

Descriptive mineral science – Study of mineral groups based on structure, mineral chemistry, stability, optical properties and occurrence for the following groups. Silicates: olivine, pyroxene, amphibole, mica, talc, feldspar, quarts, garnet, beryl, epidot, Al_2SiO_5. Oxides:hematite, spinel, rutile. Carbonates: calcite, aragonite, dolomite. Phosphates: Apatite, monazite. Sulphides: Pyrite, chalcopyrite.

Unit III: (15 hours)

Laws of thermodynamics, concept of free energy, activity, fugacity, and equilibrium constant, thermodynamics of ideal, non-ideal and dilute solutions. Principles of ionic substitution in minerals. Element partitioning in mineral/rock formation and concept of simple distribution coefficients and exchange reaction distribution coefficients.

Unit IV: (15 hours)

Geochemical classification of elements. Radiogenic isotopes: Radioactive decay schemes of U-Pb, Sm-Nd, Rb-Sr, K-Ar, and growth of daughter isotopes. Radiometric dating of single minerals and whole rocks. Stable Isotopes: Nature, abundance and fractionation.

Books for reference:

1. Buerger M. Elementary Crystallogaphy. The MIT Press (May 15, 1978)
2. L. V. Azaroff. Elements of X-ray Crystallography. McGraw-Hill Companies, The (March 1, 1968)
3. Winchell. Elements of Optical Mineralogy part I and II. John Wiley and Sons (1956)
4. Wahlstrom. Optical Crystallography. John Wiley & Sons Inc; 5 edition (July 1979)
5. J.A.K. Tareen and T.R.N. Kutty A Basic Course in Crystallography. Orient Blackswan Private Limited. 2001
6. W. H. Blackburn and W. H. Dennen. Principles of mineralogy. Dubuque, IA: Wm. C. Brown Publishers. 1993)
7. Bloss F. D. Crystallography and Crystal Chemistry. Mineralogical Society of Amer (June 1994)
8. Dana: Elements of Mineralogy. John wiley & sons, inc. London: chapman & hall, limited 1922)
9. Kerr: Optical Mineralogy. Mcgraw-Hill College; 4th edition (March 1, 1977)
10. Deer, Howie Zussman: Rock forming minerals, Vol. I – IV. Geological Society of London; 2nd edition (January 30, 2006)
11. Cracknell: Crystals and their structure. Pergamon Press (July 1969)
12. Frye Keith: Modern Mineralogy. Prentice Hall; First Edition edition (May 1974)
13. William D Nesse. Introduction to Optical Mineralogy. Oxford University Press, USA; 3 edition (August 21, 2003)
14. Rutley - Mineralogy. Springer; 27th edition (November 30, 1988)
15. L. V. Azaroff. Introduction to Solids. McGraw Hill Higher Education; New edition edition (1 Mar 1984)
16. Deer, Howie Zussman: An introduction to Rock forming minerals, Vol. I – IV. Longman, London; 1969)
17. Mason B, Moore. Principles of geochemistry. John Wiley & Sons; 4th Edition edition (13 Oct 1982)

18. Gunter Faure Principles and Applications of Geochemistry. Prentice Hall; 2 edition (December 24, 1997)
19. K.C. Misra, Introduction to Geochemistry: Principles and Applications, Wiley-Blackwell, 2012
20. Cornelis Klein and Barbara Dutrow, The manual of Mineral Science, Wiley Publication 2007
21. Putnis A. Introduction to mineral Sciences, Cambridge publication, 1992
22. Nesse W. D., Introduction to Optical mineralogy. Oxford University Press. 2008
23. Dexter Perkins, Mineralogy, 3 rd edition, Pearson, 2011
24. Francis Albarède Geochemistry: An Introduction, Cambridge, 2009
25. William M White, Geochemistry, Wiley-Blackwell, 2103
26. Mason, B, Principles of Isotope Geology, J. Willey &Sons, 1982

PGETC12002–Stratigraphy and Paleontology

(4 credits = 4 hrs/week; 1 credit = 15 hrs/semester. So, 4 credits = 60 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO 1: Explain the principles of advanced stratigraphy and details of geological time scale

CLO 2: Assess Indian stratigraphic systems and their significance

CLO 3: Describe the usages of fossils for palaeoecology, palaeobiogeography, palaeoclimate, and palaeoenvironment study

CLO 4: Explain evolution of vertebrate and microfossils

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	3	3	2	3	3
CLO2	3	3	3	3	2
CLO3	3	2	3	3	2
CLO4	3	3	2	3	2

(ii) Broad contents of the course:

This course covers topics related to advance stratigraphic correlations, Indian stratigraphy, application of fossils, evolution of vertebrates and extinction, Gondwana flora, basics of micropaleontology.

(iii) Skills to be learnt:

Students will acquire skills related to stratigraphic correlations, use of advanced stratigraphic methods, identification of invertebrate, vertebrate and plant fossils, identification of microfossils.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(15 hours)

Stratigraphy: Historical developments. Types and recognition of stratification; Controls on the development of the stratigraphic records. Stratigraphic classification and correlation. Litho-stratigraphy, Bio-stratigraphy, Chronostratigraphy, Magnetostratigraphy, Cyclo-stratigraphy, Event stratigraphy, Pedostratigraphy, Seismic stratigraphy, Sequence stratigraphy and Isotope stratigraphy. Correlation. Geological Time Scale

Unit II:(15 hours)

Indian Stratigraphy: Archaeans with reference to Karnataka. Classification, lithology and correlation of Kaladgi, Badami, Bhimas, Cuddaphas and Vindyans. Paleozoic and Mesozoic stratigraphy, Gondwanas and Deccan traps.

Unit III:(15 hours)

Palaeoecology – Principles and methods; application of fossils in the study of palaeoecology, palaeobiogeography and palaeoclimate.Ichnology-classification of trace fossils and their utility in palaeoenvironmental reconstructions.

Unit IV:(15 hours)

Vertebrate Palaeontology: Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs, Evolution of horse and intercontinental migrations. Human evolution; vertebrate fossil record from India (Gondwana formations, Deccan volcanic Province, Palaeogene and Neogene sequences of India). Palaeobotany: Early plant life, colonization of land, important stages in plant evolution; Gondwana flora and role of climate in its evolution. Introduction to palynology. Introduction to micropalaeontology.

Books for reference:

1. Text book of Geology – P.K Mukherjee, World Press.
2. Geology of India, D. N. Wadia (1978), Tata Mc. Graw Hill.
3. Geology of India and Burma (6 edition) – M.S Krishnan. 2006, CBS Publishers & Distributors
4. Fundamentals of historical geology and stratigraphy of India- Ravindra Kumar. 1985. Wiley Eastern,
5. Principles of paleontology (3rd edition)-Michael Foote& Arnold I. Miller. 2006. W.H. Freeman
6. Principles of paleontology (2nd edition) – Roop and stanely. 1978. W. H. Freeman
7. Micropaleontology – Bilal Ulla haq. 1998. Elsevier
8. Geology of India- Ramakrishana.M. &Vidyanadan,R. 2010. Geological Society of India
9. Raup, D.M. and Stanley, S. M. 1971. Principles of Palaeontology, W.H. Freeman and Company. .
10. Benton, M. 1997. Basic Palaeontology: An introductory text D.HarkerAddision Wisely Longman. "
11. Prothero, D.R. 1998. Bringing fossils to life - An introduction to PaJaeobiology, McGraw Hill.
12. Benton, M.J. 2005. Vertebrate palaeontology (3rd edition). Blackwell Scientific, Oxford.
13. Willis, K.J. &McElwain, J.C. 2002. The evolution of plants Oxford University Press. '
14. Brechley, P. J., and Harper, D. A. T. 1998. Palaeoecology: Ecosystems, Environments and Evolution. By Chapman and Hall:
15. Sequence Stratigraphy: D. Emery, and K. Mayers (1996) Blackwell Publishers.
16. Principles of Sequence Stratigraphy Octavian cateneauau (2006) Elsevier
17. The geology of stratigraphic sequences: A.D. Miall (1997) Springer

PGETC12003 – Geomorphology and Structural Geology

(4 credits = 4 hrs/week; 1 credit = 15 hrs/semester. So, 4 credits = 60 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO 1: Explain the process of formation and distribution of various landforms, applications of geomorphology

CLO 2: Describe the deformation of rocks under different stress conditions

CLO 3: Explain the mechanism of various geological structures like folds, faults, shear zones, etc.

CLO 4: Describe the tectonic evolution of continents and oceans, evolution of Himalaya

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	3	3	3	2	3
CLO2	3	3	3	1	2
CLO3	3	3	3	1	2
CLO4	3	3	3	2	3

(ii) Broad contents of the course:

This course covers topics related to role of geomorphic agents in the formation of various landforms, deformation behaviour of various geological structures, and geodynamic evolution of continents and oceans.

(iii) Skills to be learnt:

Students will acquire skills related to geological and geomorphological mapping, solving problems related to mineral exploration, understand distribution of seismic zones.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(30 hours)

Geomorphology: Geomorphic principles. Weathering and soils, Mass wasting. Influence of climate on processes. Concept of erosion cycles. Geomorphology of fluvial tracts, arid zones, coastal regions, karst landscapes and glaciated ranges. Geomorphic mapping, slope analysis and drainage basin analysis. Applications of geomorphology in mineral prospecting, civil engineering, hydrology and environmental studies. Topographical maps. Geomorphology of India. Geomorphology and tectonics

Unit II: (30 hours)

Structural Geology: Stress and strain. Behaviour of rocks under stress. Mohr circle. Stereographic projections. Determination of strain in deformed rocks. Linear and planar elements in rocks - Geometry and mechanics of development of boudins, foliations and lineations. Superposed deformation. Relationship between crystallisation and deformation. Fold and folding – mechanism of folding, fold development and distribution of stress and strain in folds, superposed folding, Joints. Faults – genetic, geometric study and relation to stress. Unconformities and basement-cover relations. Gravity induced structures. Shear zones. Petrofabric Analysis: Concept, Types and Techniques. Geometrical analysis of simple and complex structures on macroscopic scale.

Books for reference:

1. Physical Geology. Carla. W Montgomery, Wm C. Brown Publishers, 1990
2. A Text Book of Geomorphology. Dayal.P, Rajesh Publication, New Delhi 2007
3. Principles of Geomorphology, W.D Thornburry Wiley, 1969
4. Geomorphology. Charley, R.J., Suhumm, S.A &Sugden, D.E, Routledge, 1985
5. Earth: An Introduction to Physical Geology (10th Edition), Tarbuck, E.J., Lutgens, F.K& Dennis Tasa. Prentice Hall, 2010
6. Billings, M.P. Structural Geology. Prentice-Hall; 3Rev e. edition (April 1972)
7. Lahee. Field Geology. RareBooksClub.com (May 19, 2012)
8. Ramsay,J.G. Folding and fracturing of rocks. The Blackburn Press (February 2004)
9. Whitten,E.H.T. Structural Geology of folded rocks. Chicago, Rand Mcnally. 1966)
10. Badgley,P.C. Structural methods for the exploration geologist. Harper; First Edition edition (1959)
11. Martin Bott, H.P. The interior of the Earth. Edward Arnold (1971)
12. Manual of Field Geology- Robert R Compton. John Wiley & Sons, Inc. (1962)
13. G. H. Davis, S. J. Reynolds, C. F. Kluth, Structural Geology of Rocks and Regions, Wiley.
14. Haakon Fossen, Structural Geology. Cambridge University Press.
15. Kent C. Condie, Plate Tectonics and Crustal Evolution. Butterworth-Heinemann, 1997

PGEPC12004–Practical: Mineralogy & Palaeontology

(2 credits = 4 hrs/week; 1 credit = 30 hrs/semester. 2 credits = 60 hrs/semester)

Unit I:(30 hours)

- Crystallography: Study of 32-point groups, Representation of symmetry on stereograms, Stereographic projection, Axial ratios.
- Descriptive Mineralogy: Study of minerals belonging to major groups and their identification with the aid of megascopic characters.
- Optical mineralogy: Relative refractive index by Becke method, Determination of vibration direction, extinction angle, pleochroism and optic sign for rock forming minerals. Identification of common rock forming minerals under microscope.

Unit II:(30 hours)

- Paleontology: Study of invertebrate, vertebrate and plant fossils. Study of microfossils. Chronostratigraphy.

PGEPC12005– Practical: Geomorphology and Structural Geology

(2 credits = 4 hrs/week; 1 credit = 30 hrs/semester. 2 credits = 60 hrs/semester)

Unit I:(30 hours)

- Structural Geology: Preparation and interpretation of geological maps and sections. Dip and strike & thickness problems. Interpreting underground structure from borehole data. Structural problems concerning economic mineral deposits. Stereographic projections. Recording and plotting of field data. Plotting and interpretation of petrofabric data and resultant diagrams. Study of large tectonic features of the Earth.

Unit II:(30 hours)

- Geomorphology: Toposheet reading, Preparation of drainage map, Preparation contour map, Morphometry, Preparation of drainage, Preparation of drainage density map, Preparation of drainage frequency map, Preparation of Relative Relief map. Drainage pattern analysis.

Skill Enhancement Course -1 (Foundation Course – Man-making)

PGEFS12101 - Field work

(2 Credits = 4 hrs/week; 1 credit = 30 hrs/semester. So, 2 credits= 60 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO 1: Explain and experience the basics of on-field training and real time opportunity to analyse various geological structures and lithologies on field.

CLO 2: Enhance one's mapping skills.

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	2	3	3	3	3
CLO2	3	3	1	2	2

(ii) Broad contents of the course:

This course helps the students to experience the real time geological problems on field and grab knowledge on field mapping.

(iii) Skills to be learnt:

Students will acquire skills related to interpretation of field geological problems which shall enhance their skills as a geologist.

The detailed contents of this course:

Compulsory field work on places of Geological importance.

PGETA12102– Basics of Geoinformatics

(3 credits = 3 hrs/week; 1 credit = 15 hrs/semester. So, 3 credits = 45 hrs/semester)

(iv) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO 1: Explain the basic concepts of electromagnetic radiation, its interaction with the earth's surface and atmosphere

CLO 2: Describe the types of sensors, platforms and types of remote sensing

CLO 3: Explain GIS principles and its applications as well as aerial photography

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	2	3	3	3	3
CLO2	3	3	1	2	2
CLO3	1	3	3	2	3

(v) Broad contents of the course:

This course covers topics related to principle of remote sensing, reflectance of earth's surficial features, sensors, platforms, RADAR, LIDAR, SAR imaging, GIS integration with remote sensing and aerial photography.

(vi) Skills to be learnt:

Students will acquire skills related to interpretation of remotely sensed images, use basic analytical tools in GIS, interpretation of aerial photography.

(vii) The detailed contents of this course, suggested books/references:

Unit I:(10 hours)

Basic principles of Remote Sensing: Definition and components, Electro Magnetic Radiation; Wavelength regions of electro-magnetic radiation; Types of remote sensing with respect to wavelength regions; Black body radiation; Reflectance; spectral reflectance of land covers.

Unit II:(15 hours)

Sensors and platforms: Types of sensors: Multispectral, Hyper-spectral, Microwave, scanners-along track and across track; Platform and their types-Geostationary and Polar orbiting, platforms based on altitudes. Major satellite missions, marine/ocean observation satellites.

Unit III:(10 hours)

Introduction to RADAR, LIDAR, SAR and Hyperspectral remote sensing. Integration of GIS with remote sensing.

Unit IV:(10 hours)

Aerial Photography: Interpretation keys; Instruments used in the analysis. Photogrammetry - Measurements. Applications of aerial photography in geological studies.

Books for reference:

1. D.R.Lueder. Aerial photographic interpretation, Principles and applications. McGraw-Hill New York. (1959)
2. Photogeology - Miller, J.C.
3. Manual of colour aerial photography -Ed. Smith, J.T.Jr. American society of photogrammetry. 1968
4. Manual of photogrammetry - Ed: MorrieM.Thompson.
5. Manual of Remote sensing - Ed: Robert G Reeves.
6. Theory of pattern recognition and modern forecasting - V.Karpin and Wright Pattern.
7. Remote sensing in Geology - Parry S. Siegal& Alan. R.Gillespie
8. Manual of photographic interpretation - Ed: Colwell, R.N.
9. Thomas M Lillesand, R W Kieffer, J W Chipmas. Remote sensing and image interpretation. John Wiley & Sons, 2009

PGETG12301– Earth Resources / Fossils and Their Applications

(3 credits = 3 hrs/week; 1 credit = 15 hrs/semester. So, 3 credits = 45 hrs/semester)

Earth Resources

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO 1: Describe the various resources of earth

CLO 2: Explain the advantages, limitations and conservation of mineral resources

CLO 3: Explain the advantages and limitations of water resources

CLO 4: Explain the advantages and limitations of energy resources

CLO 5: Describe the hydrological cycle and associated processes

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	3	2	1	2	2
CLO2	3	3	3	2	3
CLO3	3	3	2	3	3
CLO4	3	3	2	2	2
CLO5	3	3	2	3	3

(ii) Broad contents of the course:

This course covers topics related to classification, process of formation and conservation of mineral resources, various energy resources, fossil fuels, processes of hydrological cycles.

(iii) Skills to be learnt:

Students will acquire skills related to classification and formation of mineral deposits, fossil fuels, development with respect to energy and water resources.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(15 hours)

Earth Resources: Resource reserve definitions; mineral, energy and water resources. A brief overview of classification of mineral deposits with respect to processes of formation. Methods of mineral conservation.

Unit II:(15 hours)

Primary and Secondary Energy. Difference between Energy, Power and Electricity. Renewable and Non-Renewable Sources of Energy. Major Types and Sources of Energy. Resources of Natural Oil and Gas, Coal and Nuclear Minerals. Potential of Hydroelectric Power, Solar Energy, Wind, Wave and Biomass Based power and Energy.

Unit III:(15 hours)

Water resources and its role in the development. Hydrological cycle and processes.

Books for reference:

1. Energy and the Environment by Fowler, J.M 1984. McGraw-Hill
2. Global Energy Perspectives by NebojsaNakicenovic 1998, Cambridge University Press.
3. Energy Resources and Systems: Fundamentals and Non-Renewable Resources by Tushar K. Ghoshand M. A. Prelas. 2009, Springer
4. Introduction to Wind Energy Systems: Hermann-Josef Wagner and JyotirmayMathur. 2009, Springer.
5. Renewable Energy Conversion, Transmission and Storage. Bent Sorensen, 2007, Springer

OR

Fossils and Their Applications

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO 1: Explain the basic idea about fossils and microfossils

CLO 2: Describe fossilization process and different types of fossils

CLO 3: Describe the application of fossils for paleoecology, paleobiogeography and paleoclimate interpretation

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	3	3	2	2	3
CLO2	3	2	3	3	3
CLO3	2	2	3	3	3

(ii) Broad contents of the course:

This course covers topics related to fossilization process, geological time scale, various fossil groups, and application of fossils.

(iii) Skills to be learnt:

Students will acquire skills related to recognition of various fossil groups, role of fossils in hydrocarbon exploration, correlation of coal seams, mineral deposits, and pollution.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(15 hours)

Introduction to fossils. Definition of fossil, fossilization processes (taphonomy), taphonomic attributes and its implications, modes of fossil preservation, role of fossils in development of geological time scale and fossils sampling techniques.

Unit II:(15 hours)

Introduction to various fossils groups. Brief introduction of important fossils groups: invertebrate, vertebrate, microfossils, spore, pollens and plant fossils.

Unit III:(15 hours)

Application of fossils: Principles and methods of paleoecology, application of fossils in the study of paleoecology, paleobiogeography and paleoclimate. Societal importance of fossils in hydrocarbon exploration. Application of spore and pollens in correlation of coal seams. Fossils associated with mineral deposits, fossils as an indicator of pollution.

Books for reference:

1. Schoch, R.M. 1989. Stratigraphy, Principles and Methods.VanNostrand Reinhold.
2. Clarkson, E.N.K.1998. Invertebrate Paleontology and Evolution George AlIen&Unwin
3. Prothero, D.R. 1998. Bringing fossils to life - An introduction to Paleobiology, McGraw Hill.
4. Benton, M.J. 2005. Vertebrate paleontology (3rd edition). Blackwell Scientific, Oxford.
5. Colbert's Evolution of the Vertebrates: A History of the Backboned Animals Through Time,
6. EdwinH. Colbert, Michael Morales, Eli C. Minkoff, John Wiley & Sons, 1991.

Semester II

PGETC22006–Igneous, Sedimentary and Metamorphic Petrology

(4 credits = 4 hrs/week; 1 credit = 15 hrs/semester. So, 4 credits = 60 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Describe the origin of various rocks in different geological environments.

CLO-2: Explain the different physical and chemical processes affecting the rocks of various types.

CLO-3: Explain the significance of various lithological formations, their relations to tectonic settings and their multidisciplinary applications

CLO-3: Describe the occurrence of various earth processes.

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**
CLO1	3	3	1	3	3
CLO2	2	3	2	2	2
CLO3	3	3	2	3	3
CLO4	3	3	2	3	3

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

(ii) Broad contents of the course:

This course covers topics related to basics of petrological formations, tracing their history in the geological time period, and covering various physical and chemical aspects of the basic earth systems formed due to the three sects of petrology: igneous, sedimentary, and metamorphic. Understanding of melt generation and crystallization mechanism and their link to tectonic settings is vital for the geological assessment of an area.

(iii) Skills to be learnt:

Students will acquire skills related to solving lithological problems using various classification schemes and sampling processes; skills related to assessing mineralogical composition and textural differences with special focus on facies analysis using petrological environments. Also, they will be acquiring skills of estimating the occurrences of various related earth materials based on the petrological significance of an area.

(iv) The detailed contents of this course, suggested books/references:

Unit I: Magma; physical properties, origin and evolution, Magma and plate tectonics, Gibb's phase rule, study of binary and ternary granitic and basaltic systems

Unit II: Igneous Petrology: Classification: Classification based on fabric, field relations, mineralogical and modal, IUGS classification of plutonic, hypabyssal and volcanic rocks, Irvine-Baragar classification of volcanic rocks, classification of basalt, igneous rock names. Occurrence and Origin**:** Granodiorite - Diorite, syenite – Nephaline syenite; Gabbro – Peridotite – Dunite; Anothosites, Lampropyres, Kimberlite, Carbonatites; Dolerites, Pegmatites; Rhyolites – Trachytes; Andesites & Dacites, Basalts. Crystal-melt equilibria in magmatic systems and petrotectonic associations: Continental Flood Basalt, Large Igneous Provinces, Layered Igneous Complexes, Continental Alkaline Rocks, Alkaline Cratonic Associations, I-, S-, A-Granites.

Unit III: Sedimentary petrology: Sedimentary processes and their products. Classification of sediments. Diagenesis & Lithification. Sedimentary structures. Classification of sedimentary rocks. Mineral composition, structure and textures of Clastic and non-Clastic sediments and Residual deposits. Origin, occurrence and characteristics of common sedimentary rocks - quartz arenites, arkoses and greywacks. Siliceous and calcareous deposits. Sedimentary environments and facies. Palaeocurrents and basin analyses.

Unit IV: Metamorphic Petrology: Factors controlling metamorphism; types of metamorphism; transient geotherm pressure-temperature regimes; protolith types and characteristic metamorphic minerals; metamorphic textures; projection in positive and negative space; ACF, AKF and AFM diagrams; metamorphic facies

and facies series; metamorphic zones; thermodynamic principles of metamorphic reactions; regional metamorphism of pelitic, carbonate and mafic rocks; contact metamorphism; granulite, eclogite and migmatite; metamorphic differentiation, metamorphic terranes in relation to plate tectonics.

Books for Reference:

1. Best, M. G. Igneous and Metamorphic Petrology, 2nd Edn., Blackwell, 2003
2. Cox, K. G., Bell, J. D. and Pankhurst, R. J. The Interpretation of Igneous Rocks. Unwin Hyman, 1979
3. Hall, A. Igneous Petrology, 2nd Edn., Longman, 1996
4. McBirney, A. R. Igneous Petrology, 3rd Edn., Jones & Bartlett, 2006
5. Middlemost, E. A. K. Magmas and Magmatic Rocks. Longman, 1985
6. Parfitt, E. and Wilson, L. Fundamentals of Physical Volcanology. Wiley-Blackwell, 2008.
7. 2nd Ed., Winter, J. D. Introduction to Igneous and Metamorphic Petrology. Prentice-Hall India,2010
8. Collinson, J., Mountney, N., Thompson, D., Sedimentary Structures, Terra Publishing, 3rd Edn., 2006
9. Nicholls, G. Sedimentology and Stratigraphy. Wiley-Blackwell, 1999
10. Prothero, D.R. and Schwab, F. Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy, 2nd Edn., W.H. Freeman, 2003
11. Selley, R.C., Applied sedimentology, 2nd Edn., Academic Press, 2000
12. Tucker, M.E. Sedimentary Petrology, 3rd Edn., Blackwell Science, 2001
13. Stuwe, K. Geodynamics of the Lithosphere. Springer-Verlag, 2007
14. Philopotts, A.R. Principles of Igneous and Metamorphic Petrology, Prentice Hall, 1994
15. Yardley, B.W.D. Metamorphic Petrology, Longman, 1989

PGETC22007-Climatology

(3 credits = 2 hrs/week; 1 credit = 15 hrs/semester. So, 3 credits = 45 hrs/semester)

(v) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Describe a systematic observation on Climate and implications of climate change.

CLO-2: Explain the significance of climatology.

CLO-3: Evaluate the various problems and outcomes of concerns related to the climatology

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	3	3	2	3	3
CLO2	2	3	2	3	3
CLO3	1	3	3	3	3

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

(vi) Broad contents of the course:

This course covers a detail study on ocean sciences, climate sciences and atmospheric sciences.

(vii) Skills to be learnt:

Students will acquire skills related to different type of climate, vertical distribution of atmosphere, different meteorological parameters, causes of global warming, recognition of several thunderstorms due to global warming, ocean-bottom topography and a detail study on biological productivity and mineral resources under ocean.

(viii) The detailed contents of this course, suggested books/references:

Unit I: (10 hours)

Role of oceans in climate. continents and ocean floor –continental shelf, slope, rise and abyssal plains, Ocean currents, waves and tides, current systems, oceanic conveyor belt, thermohaline circulation, Ocean Circulation, Coriolis effect and Ekman spiral, convergence, divergence and upwelling, El Nino and La Nina. Sea level processes and Changes, Indian Ocean, Formation of Bottom waters; major water masses of the world's oceans.

Unit II: (15 hours)

Role of atmosphere in climate control. Atmospheric circulations, Atmospheric turbulence and boundary layer, lapse rate and stability, air- sea interactions on different space and time scales, general circulation of the atmosphere and ocean. Climatic and sea level changes on different time scales. Weather systems of India, - Monsoon system, cyclone and jet stream, Western disturbances and severe local convective systems, ozone depletion.

Unit III: (20 hours)

Climate and weather, Weather Forecasting, Acquisition of weather Information, forecasting techniques, satellites and weather forecasting, Earth's energy budget. Temperature: Temperature and Heat transfer, Earth's radiation balance; latitudinal and seasonal variation of insolation, temperature, pressure, Air masses, wind belts and cyclones Humidity: variation and measurement. Clouds: classification and vertical development. Precipitation: processes, classification and measurement. Air masses, monsoon, Jet streams, tropical cyclones, and El

Nino Southern Oscillation ENSO. Climate classification – Koppen's and Thornthwaite's scheme of classification. Global warming and greenhouse effect, the temperature record, Global warming and the future. Climate change, Thunderstorms. Indian monsoons: Components of Monsoon, Synoptic systems of Monsoon, Indian Monsoon Rainfall and its variability.

Books for reference:

1. Essentials of Oceanography- Alan P. Trujillo and Harold V. Thurman (11th edition)- 2013, Pearson
2. Physical Geology Earth Revealed (Sixth Edition). 2006. Carlson-Plummer-McGeary.McGraw-Hill
3. Marine Geologyby John Wiley & Sons(1950),
4. Weisberg J., and Parish,H., Introductory Oceanography. McGrawHill,1974.
5. Ahamed,E. Coastal geomorphology of India. Orient long man, NewDelhi,
6. Meteorology by Eric W. Danielson, James Levin, ElliotAbrams
7. Essentials of Meteorology: An invitation to the Atmosphere by C. DonaldAhrens
8. Meteorology: Moran andMorgon
9. Meteorology by Eric W. Danielson, James Levin, ElliotAbrams
10. Essentials of Meteorology: An invitation to the Atmosphere by C. DonaldAhrens
11. Meteorology: Moran and Morgon
12. Climatology, DS Lal, ShardaPustakBhavan (2011)
13. Climatology, Savindra Singh, PrayagPustak,(2006).
14. Environmental Geology (9 edition) – Montgomery. 2010.McGraw-Hill
15. Ecology, environment and pollution – ABalasubramanian
16. Environmental Geology – K SValdia
17. Environmental Geology –Flawn
18. All you wanted to know disasters – B K Khanna. 2005. \New India Publishing Agency
19. Environment- A Global concern (12 edition) – William Cunningham&Mary Cunningham. 2011.McGraw-Hill

PGETC22008–Hydrogeology and Environmental Geology

(3 credits = 3 hrs/week; 1 credit = 15 hrs/semester. So, 3 credits = 45 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Explain the occurrence of groundwater in different geological formations.

CLO-2: Demonstrate the different methods of exploration of groundwater.

CLO-3: Describe different techniques related to construction of different types of groundwater wells and their maintenance, chemical aspects related to groundwater

CLO-4: Describe the knowledge of management of groundwater resource.

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	3	3	3	2	1
CLO2	3	2	3	2	2
CLO3	3	2	3	3	2
CLO4	3	1	3	2	2

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

(ii) Broad contents of the course:

This course covers topics related to review of basics, groundwater occurrence and exploration, groundwater wells and groundwater management, and groundwater chemistry.

(iii) Skills to be learnt:

Students will acquire skills related to solving groundwater exploration problems using geophysical methods; skills related to assessing well efficiency, well design and aquifer parameters. Also, they will be acquiring skills of estimating groundwater recharge using different methods.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(10 hours)

Origin of water; Hydrologic cycle; Classification of aquifers; hydrological properties of rocks; water table contour maps, Hydro-stratigraphic units, Theory of groundwater flow, Darcy‟s Law and its applications, determination of permeability in laboratory and in field.

Unit II: (13 hours)

Groundwater quality, graphical presentation of water quality data; Coastal aquifers and salt water intrusions. Types of wells, drilling methods, construction, design, development and maintenance of wells. Pumps tests: methods, data analysis and interpretation; Surface and Subsurface geophysical methods of exploration. Remote Sensing applications in groundwater exploration.

Unit III: (10 hours)

Time scales of global changes in the ecosystems and climate. Impact of circulations in atmosphere and oceans on climate, rainfall and agriculture. Waterlogging problems due to indiscrete construction of canals, reservoirs and dams.

Unit IV: (12 hours)

Soil profiles and soil quality degradation due to irrigation; Use of fertilizers and pesticides. Influence of neotectonics in seismic hazard assessment. Preparation of seismic hazard maps. Distribution, magnitude and intensity of earthquakes. Landslide hazards: causes and investigations. Floods: causes and control.

Books for reference:

1) Applied Hydrogeology (4th edition) (2014) by C. W. Fetter Jr. Pearson New International Edition.
2) Applied Hydrogeology of Fractured Rocks (2nd edition) (2010) by B. B. S. Singhal and R. P. Gupta. Springer Publication.
3) Groundwater Hydrology (3rd edition) (2005) by David Keith Todd and Larry W. Mays. John Wiley & Sons, Inc.
4) Hydrogeology – Principles and Practice (2nd edition) (2014) by Kevin M. Hiscock and Victor F. Bense. Wiley Blackwell.
5) Groundwater Science (2nd edition) (2013) by Charles Fitts. Academic Press.
6) Applied Hydrology (International Edition) (1988) by Ven Te Chow, David R Maidment and Larry W Mays. McGraw-Hill Book Company.
7) Ground Water (3rd edition) (2007) by H. M. Raghunath. New Age International Publishers.
8) Hydrology – Principles, Analysis, and Design (2nd edition) (2006) by H. M. Raghunath. New Age International Publishers.
9) Water Wells and Boreholes (2nd edition) (2017) by Bruce Misstear, David Banks, and Lewis Clark. Wiley Blackwell.
10) Groundwater and Wells (3rd edition) (2007) by Robert J. Sterrett (Editor). Johnson Screens.
11) Groundwater Geochemistry and Isotopes (2015) by Ian Clark. CRC Press.
12) Chemical and Isotopic Groundwater Hydrology (3rd edition) (2004) by Emanuel Mazor. Marcel Dekker, Inc.
13) Valdiya, K.S. 1987 Environmental Geology – Indian Context. Tata McGrawHill.
14) Keller, E.A. 1978 Environmental Geology, Bell and Howell,USA.
15) Bryant, E. 1985 Natural Hazards, Cambridge UniversityPress.
16) Patwardhan, A.M. 1999 The Dynamic Earth System. PrenticeHall.
17) Subramaniam, V. 2001 Textbook in Environmental Science, NarosaInternational.
18) Bell, F.G. 1999 Geological Hazards, Routledge, London.
19) Smith, K. 1992 Environmental Hazards. Routledge,London.

PGEPC22009 –Practical:Petrology

(2 credits = 4 hrs/week; 1 credit = 30 hrs/semester. 2 credits = 60 hrs/semester)

Petrology: Study of mega structures, textures and mineralogy of igneous, sedimentary and metamorphic rocks. Microscopic study of Igneous, sedimentary and metamorphic rocks. Interpretation of Geochemical data

PGEPC22010–Practical: Hydrogeology, Environmental Geology and DIP

(2 credits = 4 hrs/week; 1 credit = 30 hrs/semester. 2 credits = 60 hrs/semester)

Unit I: Hydrogeology: Preparation of water level contour maps and their interpretation; Calculation of Porosity, permeability, groundwater storage; Groundwater Exploration by

Resistivity methods(Schlumberger and Winner methods); Pumping Test Data analysis; Water Quality data analysis

Unit II: DIP: Interpretation of Images; Registration: Transfer of Information from Imagery to Base Map; Classification; Exposure to various Image Processing Techniques and Generation of digitally processed outputs.

Unit III: Environmental Geology: Study of seismic and flood prone areas of India. Classification of ground water for use of drinking, irrigation and industrial purposes. Evaluation of Environmental impact of air pollution, ground water, landslides, deforestation, cultivation and building construction in specified areas.

PGETA22103– Digital Image Processing

(3 credits = 3 hrs/week; 1 credit = 15 hrs/semester. So, 3 credits = 45 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Explain the basic concepts of remote sensing.

CLO-2: Demonstrate knowledge in image processing.

CLO-3: Describe various applications of RS and GIS to understand Image processing and thematic maps.

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	1	1	2	3	3
CLO2	2	3	2	3	3
CLO3	3	3	2	3	3

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

(ii) Broad contents of the course:

This course covers topics related to principle of remote sensing, detail concept of image processing, LULC classification,Fourier series, Fuzzy logic, ISODATA, and PCA analysis.

(iii) Skills to be learnt:

Students will acquire skills related to collection and interpretation of remotely sensed images, use of basic analytical tools in geospatial technology, concept of Fourier series, fuzzy logic and statistical analysis.

(iv) The detailed contents of this course, suggested books/references:

Unit I :(15 hours)

Data collection, data analysis, data collection errors, Remote sensing data requirements, image processing functions, image data formats. Image quality assessment: Image enhancement: Image reduction and magnification, contrast enhancement- linear and nonlinear enhancements, Band ratioing, spatial filtering- spatial convolution filtering, Fourier transformation, principal component analysis.

Unit II :(10 hours)

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

Unit III :(10 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.

Unit IV :(10 hours)

Thematic map accuracy: Landuse/Landcover map accuracy assessment, sources of errors in remote sensing derived thematic products, error matrix, analysis to assess the accuracy of remote sensing derived information.

Books Recommended

1. John R Jensen Remote Sensing of the Environment: An Earth Resource Perspective (2nd Edition). Prentice Hall; 2 edition (May 11,2006)
2. James B. Campbell. Introduction to Remote Sensing, Fifth Edition. The Guilford Press; Fifth Edition, Fifth Edition edition (June 21,2011)
3. David P. Paine, James D. Kiser. Photography and Image Interpretation. Wiley; 3 edition (February 14,2012)
4. Robert H. Webb PhD, Diane E. Boyer and Raymond M. Turner Dr. Repeat Photography: Methods and Applications in the Natural Sciences. Island Press; 1 edition (November 15,2010)

PGETS22104– Social Orientation Course

(2 credits = 2 hrs/week; 1 credit = 15 hrs/semester. So, 2 credits = 30 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Explain the basic concepts of social problems; their importance and awareness.

CLO-2: Develop mental and physical health through Yoga.

CLO-3: Describe Smart cities program of Government of India, Urban development, Swachh Bharat Abhiyan.

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	1	1	2	3	3
CLO2	2	3	2	2	3
CLO3	3	3	2	3	2

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

(ii) Broad contents of the course:

This course covers topics related to Social Problems; their importance and awareness, mental and physical health through Yoga, Smart cities program, urban development and Swachh Bharat Abhiyan.

(iii) Skills to be learnt:

Students will acquire skills related to collection and interpretation of Social Problems, use of yoga in mental and physical health, concept of brif understanding of smart city development, Indian Constitution; Public Administration etc.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(10 hours)

Social Problems: Importance of the Study of Social Problems; Problems of Aged. Awareness on anticorruption: Ethics, Anti-corruption, Vigilance, Details of the organization/agencies associated with anticorruption, Corruption free Society. Youth in nation building

Unit II:(5 hours)

Yoga: Concept and Practice, International day of Yoga. Mental and physical health through Yoga.

Unit III:(10 hours)

Smart cities program of Government of India. Its Mission and Objectives: Urban development. Role of various stake holders associated with Smart city programs in India. Swachh Bharat Abhiyan' (Clean India Mission): Mission, objective and citizen responsibilities. Indian Constitution

Unit IV:(5 hours)

. Transferring geological knowledge to the benefits of society. Environmental awareness

Books Recommended

1. Ahuja, Ram 2000. Social Problems in India, New Delhi: RawatPublications.
2. Beteille, Andre 1992. Backward Classes in Contemporary India, New Delhi:OUP
3. Beteille, Andre 1974. Social Inequality, New Delhi: OUP
4. Bereman, G.D. 1979. Caste and Other Inequalities: Essay in Inequality, Meerut: FolkloreInstitute.
5. Dube, Leela 1997. Women and Kinship, Comparative Perspectives on Gender in South andSoutheast Asia, New Delhi: SagePublication.
6. Desai, Neera&UshaThakkar 2007. Women in Indian Society, National Book Trust,India.
7. SatyaMurty, T.V. 1996. Region, Religion, Caste, Gender and Culture in Contemporary India, NewDelhi:OUP.

PGETG22302– Hazards, Disaster Mitigation and Management/ Introduction to Earth Surface Processes

(3 credits = 3 hrs/week; 1 credit = 15 hrs/semester. So, 3 credits = 45 hrs/semester)

Hazards, Disaster Mitigation and Management

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Explain various types of disaster.

CLO-2: Demonstrate the management of disasters.

CLO-3: Illustrate application of remote sensing and GIS in disaster management.

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	2	3	3	3	2
CLO2	1	3	3	3	2

CLO3	1	2	3	3	2

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

(ii) Broad contents of the course:

This course covers topics on landslide and land-subsidence, hazard zonation and their mapping, post disaster recovery & rehabilitation. Techniques of monitoring and design against the disasters and disaster related infrastructure development.

(iii) Skills to be learnt:

Students will acquire skills related to different type of risk and hazards, their management, various aspects of remote sensing and GIS in risk management.

(iv) The detailed contents of this course, suggested books/references:

(Courses offered to students from other departments)

Unit I:(20 hours)

Concepts of disaster; Types of disaster: natural and manmade - cyclone, flood, land slide, land subsidence, fire and earthquake, tsunami and volcanic eruption. Issues and concern for various causes of disasters. Disaster management, mitigation, and preparedness, Techniques of monitoring and design against the disasters, Management issues related to disaster.

Unit II:(15 hours)

Disaster Management in India: Risk, Vulnerability and Hazard Mitigation through capacity building. Legislative responsibilities of disaster management; disaster mapping, assessment-disaster risk & vulnerability reduction. Post disaster recovery & rehabilitation. Disaster related infrastructure development.

Unit III:(10 hours)

Hazard Zonation Mapping, Remote-sensing and GIS applications in real time disaster monitoring. Prevention and rehabilitation.

Books Recommended

1. Bell, F.G., 1999. Geological Hazards, Routledge,London.
2. Bryant, E., 1985. Natural Hazards, Cambridge UniversityPress.
3. Smith, K., 1992. Environmental Hazards.Routledge,London.
4. Subramaniam, V., 2001. Textbook in Environmental Science, NarosaInternational

OR

Introduction to Earth Surface Processes:

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Explain the concepts of earth surface processes.

CLO-2: Interpret climate change and geomorphic responses.

CLO-3: Describe natural hazards, and broad applied aspects of geomorphology.

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	1	3	2	3	3
CLO2	2	3	2	3	2
CLO3	3	3	2	3	3

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

(ii) Broad contents of the course:

This course covers topics on different geomorphic agencies and their landform, hazard related to earth surface processes and formation of the soils.

(iii) Skills to be learnt:

Students will acquire skills related to different type of gemorphological agencies and associated landforms, their variation with respect to climate change, risk and associated hazards.

(iv) The detailed contents of this course, suggested books/references:

Unit I: (15 hours)

Historical development in the concepts of earth surface processes, terrestrial relief, scales in geomorphology. Weathering and formation of soils.

Unit II: (15 hours)

Karst and speleology, slope and catchment erosion processes. Fluvial, aeolian, glacial, peri-glacial and coastal processes and resultant landforms.

Unit III: (15 hours)

Controlling factors (tectonics, climate, sea level changes and anthropogenic) and surface Processes. Climate change and geomorphic response. Geomorphic response to tectonics, sea level/base level change, anthropogenic affects. Surface processes and natural hazards. Applied aspects of geomorphology.

Books Recommended

1. Alien, P.A., 1997. *Earth Surface Processes,* Blackwell publishing.
2. Bloom, A.L., 1998. *Geomorphology: A Systematic Analysis of Late Cenozoic Landforms,* Pearson Education.
3. Bridge, J.S. and Demicco, R.V., 2008. *Earth Surface Processes, Landforms and Sediment Deposits,* Cambridge UniversityPress.
4. Esterbrook, D.J., 1992. *Surface Processes and Landforms,* MacMillan Publ.
5. Kale, V.S. and Gupta A 2001 *1ntoduction to Geomorphology,* Orient LongmanLtd.
6. Leeder, M. and Perez-Arlucea M 2005 Physical processes in earth and environmental sciences, Blackwell' publishing.
7. Summerfield M A 1991Globle *Geomorphology* PrenticeHall.
8. Wllcock, P.R., Iverson R M (2003) Prediction in geomorphology ' AGU Publication.

Semester III

PGETC32011– Ore Geology and Mining Geology

(4 credits = 4 hrs/week; 1 credit = 15 hrs/semester. So, 4 credits = 60 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO 1: Explain the process of formation of ore deposits
CLO 2: Describe Indian distribution of metallic and non-metallic ore minerals
CLO 3: Explain various mineral exploitation techniques

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	3	3	3	3	3
CLO2	3	2	1	3	2
CLO3	3	3	3	2	3

(ii) Broad contents of the course:

This course covers topics related to formation of ore deposits, characteristics of different ore mineral groups, association of ores with rocks, Indian distribution of ores, various mining techniques.

(iii) Skills to be learnt:

Students will acquire skills related to ore geology and exploration methods,salient features of ore mineral groups, sampling andmineral exploration techniques, scientific understanding of the underground mining methods.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(15 hours)

Processes of formation of ore deposits. Ore bearing fluids, fluid inclusion and wall rock alterations. Structural, physico-chemical controls of ore localization. Morphology of the ore deposits. Textures, paragenesis and zoning of ores and their significance. Genetic classification of ore deposits.

Unit II:(15 hours)

Ore petrology: Ores associated with mafic –ultramafic – diamonds in Kimberlite, REE in Carbonatites, Ti-V, Chromite and PGE, Ni ores; Ores in acidic igneous rocks – Fe-P, Zn-Pb-Cu ores. Ores of sedimentary affiliation viz., Chemical and Clastic sediments, stratiform and strata bound ore deposits – Fe-Mn and non-ferrous ores. Placer deposits. Ores of metamorphic association and ores related to weathering – Residual Deposits – Laterite, Bauxite, Ni/Au Laterites.

Unit III:(15 hours)

Indian Mineral Deposits: Mineralogy, Origin, Occurrence and Distribution of the following mineral deposits; Metallic – Au, Cu, Fe, Mn and Al. Non Metallic-abrasives, ceramics, refractories, insulators, fossil fuels. Petroliferous basins of India.

Unit IV:(15 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. Types of drilling methods. Mining hazards: mine inundation, fire and rock burst. Alluvial mining, Surface mining and quarrying, Underground mining and coal mining methods.

Books for reference:

1. The Geology of Ore Deposits – Gillbert and Park. 2007, Waveland Press,
2. Interpretation of ore Texture- Bastin E S. 1950Geological Society of America.
3. Economic mineral deposit- Mead LeRoyJensen & Alan Mara Bateman. 1981. Wiley.
4. Ore Microscopy - Cameron E N.1961. Wiley,
5. Geology of Mineral deposits- Smirnov, V.I. 1976. Mir Publishers
6. Ore Petrology – Stanton R L. 1972. McGraw-Hill
7. Ore Microscopy and Ore Petrography – Craig and Vaughan. 1994. Wiley
8. India's Mineral resources – Krishnaswami S. 1979. Oxford & IBH
9. Mineral Resources of Karnataka – B.P Radha Krishna. 1996. Geological Society of India
10. Industrial minerals and rocks – S Deb. 1980. Allied Publishers

11. Introduction to ore forming processes-Laurence Robb.2005. Blackwell Science. ltd
12. Ore Geology and Industrials Minerals: an Introduction- A.M. Evans. 1993. John Wiley & Sons
13. Understanding Mineral deposits-Misra, K.C.2000. Kluwer Academic Pub.

PGETC32012– Exploration Geology

(3 credits = 3 hrs/week; 1 credit = 15 hrs/semester. So, 3 credits = 45 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Describe the concept of mineral exploration
CLO-2: Demonstrate Mineral identification through the different exploration techniques.
CLO-3: Demonstrate Exploration surveys

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs)with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	3	3	2	3	3
CLO2	3	3	3	2	1
CLO3	3	2	3	3	2

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level 'mapping, 1 for 'Low-level 'mapping.

(ii) Broad contents of the course:

This course covers topics related to mineral exploration, sampling and drilling, , geochemical exploration, geobotonical exploration and different geophysical methods.

(iii) Skills to be learnt:

Students will acquire skills related to geophysical, geochemical and geobotonical methods in the exploration and identification of the mineral.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(10 hours)

Geological exploration: Geological criteria for mineral prospecting, Indicators of ore, Stages and methods of geological exploration and prospecting. Sampling:

methods and types. Drilling and core logging, Preparation of technical report.

Unit II:(15 hours)

Geochemical exploration: Basic principles-geochemical dispersion, geochemical mobility, geochemical dispersion of elements under deep-seated conditions, mobility under surficial 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. Surficial dispersion patterns. Anomalies in overburdens, natural water and drainage sediments. Geochemical drainage surveys. Vegetation surveys.

Unit III & IV:(20 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. 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.

Books recommended

1. Manual of mineral exploration - GSI Mispubln No 33.1975.
2. Geological Methods in Mineral Exploration and Mining. Roger Marjoribanks.2010. Springer
3. Principles and practices in mineral exploration - P K Ramam. 1989. Geological Society ofIndia,
4. Introduction to Mineral exploration – Evans. 2006. John Wiley &Sons
5. Economic Geology: Principles and Practice. Walter L. Pohl 2011. John Wiley &Sons
6. Ore microscopy and mineral exploration – R Dhanaraju. 2010. Geological Society ofIndia,
7. Geochemistry in Mineral Exploration – Rose, Hawks and Webb.1979. AcademicPress.
8. Introduction to Exploration Geochemistry.Alfred Abraham Levinson. Applied Pub.,1980
9. Introduction to Geophysical prospecting – M B Dobrin. 1988.McGraw-Hill
10. Outlines of geophysical prospecting: a manual for geologists. M.B.RamachandraRao. 1975. University ofMysore.
11. Lectures on exploration geophysics for geologists and engineers. Bheemasnkaran and V K Gour. 1977. Association of ExplorationGeophysicists,
12. Method of Geophysical exploration – T V ramachandra. 2009. Geological Society ofIndia
13. An Introduction to Geophysical Exploration (3rdEdn). Philip KeareyMichaelBrooks&IanHil. 2009.Wiley
14. MiningGeology-R.N.P.ArogyaSwamy

PGETC32013– Advanced GIS Techniques

(3 credits = 3 hrs/week; 1 credit = 15 hrs/semester. So, 3 credits = 45 hrs/semester)

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Explain the concepts of geographic space, spatio-temporal relationship, etc.

CLO-2: Describe the characteristics and functionality of DBMS, Types of DBMS structures

CLO-3: Illustrate the geocomputation for geologic and network modelling, etc.

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs)with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	1	3	2	3	1
CLO2	2	1	2	3	1
CLO3	3	2	2	3	2

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level'mapping, 1 for 'Low-level'mapping.

(ii) Broad contents of the course:

The course covers representation of geographic data, data-based definition and advantage, DBMS and their classification, hybrid data-based model, vector data storage and compression techniques.

(iii) Skills to be learnt:

The student will be able to define collection and representation of geographic data, data-based management, hybrid modelling, and geocomputational techniques. They will also be able to understand the concept of fuzzy-logic.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(10 hours)

Introduction to Geographic Data: Representing geographic space, representing spatio-temporal relationships, File formats for spatial data. Introduction to Database: Database-definition and advantage, computer files structures – simple lists, ordered sequential files, indexed files. Query

Unit II:(15 hours)

Database management system: Essentials of DBMS, levels of data abstraction and data models, characteristics and functionality of DBMS, Types of DBMS structures-Hierarchical, Network system, relational and object oriented. Hybrid database models. Database Design and storage: Conceptual database design, logical database design, and physical database design. Data Storage: Raster and vector data storage and Compression techniques

Unit III:(20 hours)

Spatial analysis meaning and scope: Spatial Decision support system, spatial statistics, Geo-computation, Typology of spatial analysis technologies. Geo-statistical measurements, Boolean operations-overlay, buffering, density analysis, Trend surface analysis. Advanced spatial analysis: Network and raster connectivity operations, Spatial interpolation and proximity operations, Fuzzy analysis. Integration and modeling of spatial data: suitability modeling, hydrographic modeling, network modeling, Distance modeling, surface modeling.

Books Recommended

1. Lo, C.P. and A.K.W., Yeung. 2007. Concepts and Techniques in Geographic Information, Systems. 2nd, Upper Saddle River, Prentice Hall (ISBN0-13-149502-X)
2. Longley, P.A., M.F. Goodchild, D.J. Maguire and D.W. Rhind. 2007. Geographic Information Systems and Science. 2nd , John Wiley & Sons (ISBN978-0-470-87001-3
3. Michael N. Demers, Fundamentals of Geographic Information Systems, 2005. Third edition, John Wiley and sons, , USA, (ISBN:0-471-20491-9)
4. Tor Bernhardsen, Geographic information System An introduction, 3rd Edition, Wiley India private ltd, New Delhi. (ISBN:978-81-265-1138-9)
5. Peter A. Burrough and Rachael A. McDonnell, Principles of Geographic Information Systems, 2009, Oxford University press, New York, (ISNB:0-19-922862-0)
6. B. Bhatta, Remote Sensing and GIS, 2008, Oxford University Press, New York,(ISBN:-0-19-560239-X).
7. Michael N. DeMers, GIS for Dummies, 2009, Wiley publications, Inc (ISBN:978-0-470-23682-6).
8. Paul A. Longley,Geographical Information Systems and Science, 2nd edition, John Wiley & sons, ltd., ISBNs: 0-470- 87000-1 (HB)
9. U.M.Shamsi, GIS Applications for Water, 2009 wastewater and storm water Systems
10. Francis J.Pierce, David Clay, "GIS Applications in Agriculture", 2007 by Taylor & Francis Group, LLC, CRC press, (ISBN: 10:0-8493-7526-6)

PGEPC32014: Practical: Exploration Geology, Engineering Geology, and Ore Petrology

(2 credits = 4 hrs/week; 1 credit = 30 hrs/semester. So, 2 credits = 60 hrs/semester)

Unit I:(10 hours)

Exploration: Mineral resources evaluation, Estimation of tonnage, averaging assay, economic analysis and resource estimation. Estimation of subsurface resources by borehole log data.

Unit II:(10 hours)

Engineering Geology: Engineering properties of rocks. Study of map, models of important engineering structures as dam sites and tunnels. Interpretation geological maps for landslide problems.

Unit III:(10 hours)

Ore Petrology: Megascopic study of common metallic minerals, industrial minerals and rocks. Reflected- Microscope and its application. Study of the Metallic mineral under reflected light microscope

PGEPC32015: Practical: GIS, Cartography and Surveying

(2 **credits =** 4**hrs/week; 1** credit = 15 hrs/semester. So, 2 credits = 30**hrs/semester)**

Unit I:(30 hours)

GIS & Cartography: Map appreciation and conventional signs, Relief and slope Maps; Representation Dot maps, Density maps-colour and gray scale patterns, index of concentration and diversification, transport networking analysis, flow maps. Quantitative symbolization and location maps: point and line pattern analysis, cartograms and 3D maps. Map registration and feature extraction.

Unit II:(10 hours)

Surveying: Plane table chain survey, Dumpy level/auto leveling

PGETD32201: Advanced Remote sensing in Geological sciences

(3 **credits =** 3**hrs/week; 1** credit = 15 hrs/semester. So, 3 credits = 45**hrs/semester)**

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Analyze Spectral and temporal characteristics of vegetation, Crop type and their classification.
CLO-2: Describe RS of soil, minerals and rocks.
CLO-3: Illustrate the geological application of geomorphology and RS in petrology.
CLO-4: Analyze the RS of surface water and biophysical characteristics.

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs)with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5

CLO1	1	2	3	3	3
CLO2	2	3	3	1	1
CLO3	2	2	3	3	2
CLO4	2	2	3	3	2

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level'mapping, 1 for 'Low-level'mapping.

(ii) Broad contents of the course:

The course covers spectral and temporal characteristics of vegetation, crop disease and assessment, advances in crop monitoring, applications of RS and GIS in petrology and urban infrastructure planning.

(iii) Skills to be learnt:

The student will be able to learn the use of RS and GIS in evaluating different rock characteristics, crop types, classifications, urban planning and infrastructure, LULC classification; also, water quality modelling using RS.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(15 hours)

Spectral characteristics of vegetation, temporal (phenological) characteristics of vegetation, vegetation index. Crop type classification concepts, spectral response of different crops. Crop diseases and assessment, advances in crop monitoring, forest change detection, forest damage assessment and forest monitoring

Unit II:(10 hours)

Remote Sensing of Soils, Remote Sensing of Rocks and Minerals; Imaging Spectroscopy of Rocks and Minerals. Geological Applications in Geomorphology; Remote Sensing in Lithology: Sedimentary, Igneous, Metamorphic – Identification of Mineral assemblages

Unit III:(10 hours)

Remote sensing in urban and infrastructure planning: Urban/suburban resolution considerations, urban land use/land cover classification system, Residential Land use, Commercial Land use, Industrial land use, Transportation infrastructure, Communication and Utilities, transport infrastructure facilities, , methods of surveys in town planning, preparation of development plans.

Unit IV:(10 hours)

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.

Books Recommended

1. John R Jensen Remote Sensing of Environment–
2. Remote Sensing with special reference to agriculture and forestry, National academy of Sciences, Washintond.C., 1970, ISBN:309-01723-8
3. Remote sensing of forest environments, concept and case studies, Kluwer academic publications,ISBN:1-4020-7405-0
4. Remote Sensing Geology, Ravi P. Gupta, Second edition, Springer, ISBN:3-540-43185-3
5. Image interpretation in Geology, Steve Drury, Third edition, Blackwell Publications, ISBN:0-07487-64992
6. Applied Remote Sensing for Urban planning, Governance and sustainability, M Netzband, W L Stefanov, C Redman(Eds), Springer,ISBN:978-3-540-25546-8
7. Remote Sensing and Geographic Information Systems for design and operation of Water Resources, Micheal F. Baumgartner, Gret A. Schultez and A.IvanJhonson.
8. Remote sensing and Image Interpretation, Lillesand, TM and Kiefer RW, 1987, JohnWiley
9. Image Interpretation in Geology, Drury, SA, 1987, Alien andUnwin

PGETA32105: Engineering Geology, Geodesy and Surveying

(3 **credits =** 3**hrs/week; 1** credit = 15 hrs/semester. So, 3 credits = 45**hrs/semester)**

(i) Course Learning Outcome:

After completion of this course successfully, the students will be able to

CLO-1: Explain the geological investigation for civil engineering projects, engineering properties of rock, properties of Dam, Reservoir, landslide etc.
CLO-2: Explain in detail about concepts of geodesy
CLO-3: Demonstrate the utility of surveying methods.

Course Learning Outcomes

Mapping of Course Learning Outcomes (CLOs)with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	1	2	3	3	3
CLO2	2	3	3	1	2
CLO3	2	2	3	2	2

Each Course Learning Outcome (CLOs) may be mapped with one or more Program Learning Outcomes (PLOs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level'mapping, 1 for 'Low-level'mapping.

(ii) Broad contents of the course:

The course covers geological investigation for civil engineering project, concept of Dam, Reservoir, landslide, concept of geotechnical engineering, Geodesy and PT and TS survey.

(iii) Skills to be learnt:

The student will be able to learn the use dam, reservoir, problem related to landslide, properties of tunnel, earthquake and seismicity etc.

(iv) The detailed contents of this course, suggested books/references:

Unit I:(20 hours)

Various stages of engineering geological investigation for civil engineering projects. Engineering properties of rocks; rock discontinuities. Physical characters of building stones. Metal and concrete aggregates. 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.

Unit II:(10 hours)

Mass movements with special emphasis on landslides and causes of hill slope instability. Earthquakes and seismicity, seismic zones of India. Aseismic design of building. Influence of geological conditions on foundation and design of buildings. Introduction to geotechnical engineering.

Unit III:(15 hours)

Geodesy: History of determining the shape and size of the earth; Coordinate Systems, Basics of geodesy, Ellipsoids and Datums. Surveying: Conventional surveying: Chain Survey, Prismatic Compass, Plane table Surveying, Dumpy level, Theodolite Surveying, classification, types and uses. Modern Surveying: Total Station Survey, Survey specifications, second & third order survey.

Books Recommended

1. Engineering and general geology. Parbin Singh, S K Kataria& Sons.2009
2. Foundations of Engineering Geology. Tony Waltham. CRC Press; 3 edition (21 April2009)
3. Engineering Geology. David George. Springer; 1 edition (November 21, 2008 Elementary surveying, Major basil Jackson
4. Surveying Volume-1, Dr. B.C. Punmia, Ashok k. Jain, Arun K. Jain, 16th edition, Lakshmi Publication Pvt. LTD, ISBN:81-7008-054-1
5. Surveying for field Scientist, JC Pugh, Metheun Ltd,ISBN:0-416-075207
6. Geodesy, Wolfgang Torge, 3rd Edition, de Gruyter, Germany,ISBN:3-11-0717072-
7. Introduction to Geodesy, the history and concepts of modern Geodesy, James R. Smith.Wiley,ISBN:0-471-16660X
8. Geodesy, George Lenard Hosmer, Jhon Wiley &sons.

Semester IV

PGEIC42016– Internship

(8 credits = 8 hrs/week; 1 credit = 15 hrs/semester. So, 8 credits = 120 hrs/semester)

Internship in GIS/RS/Geological organizations/institutions based on student"s choice to be finalized in consultation with faculty supervisor assigned from the Department.

PGERD42202 – Major Project and Dissertation

(12 credits = 24 hrs/week; 1 credit = 15 hrs/semester. So, 12 credits = 180 hrs/semester)

Students will have to produce a Project Report and submit to the department by the end of the semester which will be evaluated and graded by the University for award of marks.
There is no financial commitment on the part of the University for the internship/project. However, the University may assist the candidate in locating him / herself and issue letters to concern besides supplying any other documents/ references etc.
The project will be of 4 – 5 months.

IV. The Teaching Learning Process:

Learning is a challenging, engaging, and enjoyable activity. Learners should be encouraged to engage in a rigorous process of learning and self-discovery by adopting a highly focused and yet flexible approach to education as opposed to rote learning. Each day learners should be encouraged to focus on key areas of the course and spend time on learning the course fundamentals and their application in life and society. In teaching and learning pedagogy, there should be a shift from domain or conclusions-based approach to the experiential or processes-based approach.

Lectures should be designed to provide the learners with interesting and fresh perspectives on the subject matter. Lectures should be interactive in a way that students work with their teachers to get new insights in the subject area, on which they can build their own bridges to higher learning and not spoon feeding.

Discussions are critical components of learning, and can be used as a platform for students to be creative and critical with old and new ideas. Besides developing critiquing skills, arriving at consensus on various issues and discussion groups lead to innovative problem solving and, ultimately to success.

Simulations provide students opportunities to understand real life situations and scenarios, and solve challenges in a controlled environment or make use of them in simulating cultural experiences by locating/transposing them in new (local, regional, national and international) situations.

Real case studies, wherever possible, should be encouraged in order to challenge students to find creative solutions to complex problems of individual, community, society and various aspects of knowledge domain concerned.

Intended results can be achieved in subjects like Geology only by collective efforts. Positive collaboration in the form of team work is critical, for which, it is necessary to transcend one's prejudices and predilections so as to achieve the desired outcomes. In the process of team work, leaners will acquire the skills of managing knowledge acquisition and other collaborative learners, thereby understanding, how to incorporate and balance personalities.