Group No.	Course Code	Course Title	UNIQUE CODE
1	20CGI12	Fundamentals of Remote Sensing	201GE001
1	20CWM253	Remote Sensing and GIS in Environmental Engineering	201GE002
1	20GEO11	Application of Remote Sensing in Landuse and Landcover studies	201GE003
1	**20WLM12**	**Surface Water Hydrology**	201GE004
2	20CGI11	Fundamentals of Geostatistics	202GE001
2	20GEO12	Coastal Processes and Landforms	202GE002
2	20GEO13	Water Recharge Techniques	202GE003
3	20CGI22	Applications of Geoinformatics in Natural Resources and Environmental Management	203GE001
3	20WLM21	Watershed Planning & Management	203GE002
3	20GEO14	Basin Analysis – Morphometric and Morphotectonic analysis	203GE003
3	**20WLM22**	**Ground Water Hydrology**	203GE004
4	20CEE332	Transport processes and modelling of aquatic systems	204GE001
4	20WLM321	Wetland management	204GE002
4	**20CEE31**	**Environmental Impact Assessment**	204GE003
5	20CWM11	Numerical Analysis and Advanced Computational Methods	205GE001
5	20WLM14	**REMOTE SENSING & EOGRAPHICAL INFORMATION SYSTEM**	205GE002
5	20GEO15	Mining Geology	205GE003
5	**20WLM333**	**Global Warming and Climate Change**	205GE004
6	20CWM322	Human impact on Marine and Coastal Environment	206GE001
6	20GEO16	Petroleum Geology and Sedimentary Basins of India	206GE002
6	20WLM331	Groundwater Assessment, Development & Management	206GE003

01	GROUP-1	20CGI12	Fundamentals of remote Sensing
Exam Hours: 03		**Exam Marks: 100**	

Module -1 Introduction: Definition of terms, Concepts and types of remote sensing; evolution of remote sensing technology, stages in remote sensing technology, spatial data acquisition, interdisciplinary nature and relation with other disciplines, applications of remote sensing, advantages of RS over conventional methods of survey and inventorying.

Basic Principles of Remote Sensing : Characteristics of electromagnetic radiation; Interactions between matter and electro-magnetic radiation; Types of remote sensing with respect to wavelength regions; active and passive remote sensing, Definition of radiometry; Black body radiation; Reflectance; spectral reflectance of land covers; Spectral Signature; Radiative transfer equation; energy interaction in the atmosphere.

Module -2 Sensors: Types of sensors- passive sensors and active sensors; imaging systems, photographic sensors, characteristics of optical sensors; Sensor resolution- spectral, spatial, radiometric and temporal; Characteristic of optical detectors; Cameras for remote sensing; Film for remote sensing; non-imaging radiometers, imaging sensors, Panchromatic, Multispectral, hyperspectral, stereo images, Optical mechanical line scanner; Push broom scanner; Imaging spectrometer; space borne imaging sensors, active and passive microwave sensors; Thermal sensors; Atmospheric sensors; Sonar; LIDAR, RADAR, hyperspectral sensors.

Platforms: Types of platforms- airborne remote sensing, space borne remote sensing; Atmospheric condition and altitude; Attitude of platform; Attitude sensors; Orbital elements of satellite; Orbit of satellite; Satellite positioning systems including IRNSS, Various satellites for Land, Ocean, and atmospheric studies.

Module -3 Image Interpretation and Analysis: Fundamentals of aerial photos and satellite image interpretation; Types of imaging, elements of interpretation; Techniques of Visual interpretation; Generations of Thematic maps. Importance of ground truth, reference data, use of smart phone, geo-tagging.

Module -4 Digital Image Processing: Digital data manipulation and analysis; image rectification – Radiometric correction, Atmospheric correction, Geometric correction; image enhancement – Spatial feature manipulation and multi-image manipulation; classification techniques – Supervised classification and unsupervised classification.

Module -5 Advanced Remote Sensing Technologies: Microwave remote sensing, Synthetic Aperture Radar; Hyper spectral Imaging Spectrometer; Thermal Imaging System; Advanced Laser Terrain Mapping.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

REFERENCE BOOKS:
1. Fundamentals of Remote Sensing: George Joseph
2. Remote Sensing and Image Interpretation: Lillesand & Keifer.
3. Manual of Remote Sensing: ASP Falls Church Virginia USA.
4. Physical aspects of Remote Sensing: PJ Curran.
5. Remote Sensing Principles and Interpretation: F.F. Sabins.
6. Introduction to Remote Sensing: J.B. Campbell.
7. Introductory Digital Image Processing: A Remote Sensing Perspective, John R

02	GROUP-1	20CWM253	Remote Sensing and GIS in Environmental Engineering
Exam Hours: 03			**Exam Marks: 100**

Module 01:

Fundamentals of Remote Sensing: Definition, Physics of remote Sensing, Electromagnetic. Radiation and its interactions with atmosphere, Spectral reflectance of earth features, Resolution Spectral, Temporal and Radiometric.

Module-2

Platforms Sensors and Image Processing: Aerial Photographs, Active and passive sensors, Data products, Various satellites in orbit and their sensors, Image Processing-Visual and digital image, Interpretation, Interrelation keys, Methodology, Training sets, Ground truth verification, Image analysis, Image enhancement, Rectification, Classification methods, Users accuracy, Producers accuracy and overall accuracy.

Module-3

Introduction to GIS: Data entry, storage and maintenances, Data outputs. Data analysis, Hardware and Software

Module-04

Application of Remote Sensing and GIS: Applications of remotely sensed data for identifying solid waste disposal, forest fire mapping, EIA studies etc, Optimal routing if solid waste using GIS-Case study, Environmental sitting of industries and zoning atlas development

Module-05

Remodeling of water distribution system using GIS, Environmental degradation assessment using RS and GIS.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

- Manual of Remote sensing - Ed: Robert G Reeves.
- Theory of pattern recognition and modern forecasting - V.Karpin and Wright Pattern
- Digital Remote Sensing - Pritivish Nag M Kudrat ; Concept publication
- Principles of GIS for land and resources assessment, Burrough, P.A., 1986, Oxford.

Reference Books:

- Geographical information systems Vol 1 & 2. Edited by: Paul A.Longley, Michael F.Goodchild, David J. Maguire & David W.Rhind.
- Geographical information systems and digital image processing –
- Muralikrishna1999. Allied Publication

03	GROUP-1	20GEO11	Application of Remote Sensing in Landuse and Land cover studies
Exam Hours: 3 hours			Exam Marks(Maximum):100

Module-1

Physics of Remote Sensing : Electromagnetic Radiation, Terms and Definitions, Laws of Radiation, EM Spectrum, Sources of EMR,Interaction between EM Radiation and matter, Reflection, Absorption and Transmission, Interactions between EM Radiation and Atmosphere, Atmospheric windows

Module-2

Principles of Thermal & Microwave Remote Sensing : Principles of Thermal Remote Sensing & its applications, Interpretation of Thermal Imagery Principles of Microwave Remote Sensing & its applications, Interpretation of SAR Imagery **Image Classification**: Principles of Image Classification, Land cover classification schemes , Feature Selection &Separability Analysis , Unsupervised & Supervised classification , Classification Accuracy

Module-3

Land use / Land cover (LULC) Analysis : Land Use / Land Cover Classification System: India and Global, Visual Analysis for LULC Mapping, Digital Methods for LULC Mapping, LULC Change Detection.

Module-4

Watershed Management: Watershed: Concept, principles and need of watershed management, characterization, delineation & codification. Digital terrain analysis: Morphometric analysis, terrain indices, soil-hydrological analysis

Module-5

Soil Erosion assessment and watershed prioritization for conservation planning: Empirical, semi empirical and process based erosion models. Soil conservation measures: Agronomic, soil and mechanical. Monitoring & Impact assessment of watershed development program.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbook/Reference Books				
	Title of the book	Author Name	Publisher's Name	Publication year
1	Remote Sensing of Land Use and Land Cover: Principles and Applications	Chandra P. Giri	CRC Press	2012
2	Remote Sensing And Image Interpretation	Thomas M. Lillesand, Ralph W. Kiefer&Jonathan W. Chipman	John Wiley & Sons, USA	2015
3	Remote Sensing: Models and Methods for Image Processing	Robert A. Schowengerdt	Elsevier, London	2007
4	Remote Sensing- Principles and Applications	Floyd F. Sabins	Waveland Press	2007
5	Remote Sensing and Image Interpretation	Thomas Lillesand, **,refeiK .W hplaR nahtanoJ nampihC**	Wiley, USA	2015
6	Aerial Photographs in Geological Interpretations	Richard Ray	US Govt Press	1969
7	Principles and Application	PandeyS.N	New Age Intl, New Delhi	1987

04	**Group-1**	**20WLM12**	**SURFACE WATER HYDROLOGY**
Exam Hours: 3 hours		**Exam Marks (Maximum): 100**	

Module-1

Introduction: Scope and importance of hydrology, Hydrologic cycle, Global and India's Water resources, Applications of hydrology.

Watershed Concept: Catchment, Topographic and Ground water divide, Description of the catchment, demarking a catchment, stream patterns. Location of rain-gauges and optimum number of rain-gauges, Analysis of rainfall data, Rainfall mass curve and hyetograph, Intensity-Duration analysis, Intensity-Frequency-Duration analysis, Depth-Area-Duration analysis, Double mass curve.

Module-2

Abstractions from precipitation: Evaporation-Process, Measurement, Empirical equations and Estimation by Water budget method and Energy budget method.

Evapo-transpiration-AET & PET, Estimation by Penman's equation, Reference Crop Evapo-transpiration by Blaney Criddle formula.

Infiltration-Process, Factor affecting infiltration, Measurement, Horton's equation and Philip's equation. Infiltration indices.

Module-3

Runoff:-Process, Factors affecting runoff, API, Basin yield, Curve number method, water budgeting. Correlation, Regression analysis-simple linear and Multiple linear regression, Curvilinear regression. Classification of models, Model formulation, Lumped parameter conceptual models, Physically based models, Model performance testing.

Module-4

Hydrograph and its features, Methods of hydrograph separation, Unit hydrograph and its derivation, Unit hydrographs from complex storms and for various durations, S-curve hydrograph and its uses, Synthetic unit hydrograph.

Module-5

Flood: Design flood and its estimation- Rational method, Frequency analysis Gumbel's and Log-Pearson's type III distribution, Selection of design return period.

Flood routing- Reservoir routing: Modified Pul's method, Goodrich method, Channel routing- Prism and Wedge storage, Muskingum method.Flood control: Structural and Non-structural measures.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl.	Title of the book	Author Name	Publisher's Name	Publication year
1	Engineering Hydrology	Subramanya K	Tata McGraw Hill	1998
2	A text book of Hydrology	Jaya Rami Reddy, P	Laxmi Publications	2009
3	Principles of Hydrology	Putty, M. R.Y.	I.K. Int. Publishing House, New	2010
4	Hydrology for Engineers	Linsley R K, Kohler and	McGraw Hill, NY, USA	1958
5	Applied Hydrology	Mutreja, K. N.	Tata McGraw Hill Pub. Co., New Delhi, India	1986
6	Handbook of Applied Hydrology	Chow, V.T.	McGraw Hill, NY	1964

01	GROUP-2	20CGI11	Fundamentals of Geo-statistics
Exam Hours:03		**Exam Marks:100**	

Module -1 Basics and Fundamental Concepts: Histogram – univariate and bivariate, estimation of basic statistical parameters, viz., mean, standard deviation, variance, covariance.

Probability Theory: Introduction to probability theory, kinds of probability – classical or apriority probability, A posteriori or Frequency probability, probability models, an inside to set theory, sample space and events, conditional, joint probability and independence.

Module -2 Random Variables, Distribution Functions and Expectation: Introduction and summary, Cumulative distribution function, Density function, Expectations and moments.

Special Parametric Families of Univariate and Multivariate Distributions: Introduction and summary, Discrete and continuous distributions – binomial, poisson, exponential, Gaussian/Normal distribution functions, joint and continuous distributions, bivariate and multivariate normal distribution.

Estimation Theory: Introduction and summary, methods of finding estimators, properties of point estimators, unbiased estimation, location or scale invariance, Bayes estimators – posterior distribution, loss function approach, min-max estimators, maximum likelihood estimators.

Module -3 Stratification and Sampling: Introduction, sampling, sample mean, sampling from normal distribution, stratification and sampling.

Testing of Hypothesis: Introduction and summary, simple hypothesis testing, composite hypothesis, tests of hypotheses – sampling from normal distribution, chi-square tests, tests of hypotheses and confidence intervals, sequential test of hypotheses.

Estimation and Quality Control: Introduction, point estimates and interval estimates: basic concepts, interval estimates and confidence intervals, calculating interval estimates of the mean from large samples, calculating interval estimates of the proportion from large samples.

Module -4 Geo-statistics for Spatial Analysis and Modeling: Cluster analysis concepts and techniques, Spatial autocorrelation, Multivariate Correlation, Linear regression, Multiple regression. Statistical SurfacesInterpolation, Variogram, Krieging. geostatistical models, stochastic models, probabilistic models, Deterministic models; enthalpy; Geostatistics soft-wares- SpaceStat, S-Plus.

Module -5 Time Series and Forecasting: Introduction, variation in time series, trend analysis, time series analysis in forecasting.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Richard I.Levin, David S. Rubin, Sanjay Rastogi, Masood Hussain Siddiqui, Statistics for Management, 7th edition, Pearson Education Inc,2013
2. Alexander M Mood, Franklin A Graybill and DuaneC Boes, Introduction to the Theory of Statistics, 3rd Edition, McGraw-Hillseries in probability and statistics, (1974).
3. Fruend John E and Miller, Irwin, Probability and Statistics for Engineering, 5th Edition, Prentice Hall (1994)
4. Jay L Devore, Probability and Statistics for Engineering and Sciences, Brooks/Cole Publishing company Monterey, California (1982)
5. Sampling theory, Cochran WG

02	**Group-4**	20GEO12	**Coastal Processes and Landforms**
Exam Hours: 3 hours		**Exam Marks(Maximum):100**	

Module-1

Topography and morphological features of the ocean floor, Continental slope, Continental Shelf and Abyssal plains, Ocean trench, Ocean islands, Atolls. Plate Movements, Mid Oceanic Ridges and sea floor spreading.

Module-2

Evolution of ocean basins- Pacific, Atlantic and Indian Oceans. Ocean circulation, Ocean salinity. Brief account of Indian Coasts – West & East Coasts of India. Coastal Emergence and Submergence. Sea level changes with special reference to Holocene and present scenario.

Module-3

Coastal Processes – Nearshore and offshore processes- Fetch, Swell and Sea waves – Wave height, Wave period, Wave length, Breaker waves, Longshore currents, Wave refraction – Convergence and divergence, Rip currents. Tides – Neap and Spring Tides. Tombolo process.

Module-4

Beach morphology – Erosion & Accretion process, Typical beach profile; Estuarine morphology; Erosional and Depositional features- Longshore Bar, Ridge & Runnel system, Ebb and Flood tide deposits; deltaic deposits. Coastal Wetlands, Mud banks and their importance. Beach sediments, sediment transport and depositional environments.

Module-5

Coastal Zone Regulations (CRZ), Exclusive Economic Zone (EEZ); Minerals in the EEZ of India. Oceanic Mineral deposits, Phosphate & Manganese nodules. Shore protection measures – Protection walls, groins & dikes.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Encyclopaedia ofGeomorphology	Edited by A.S. Goudie	Routledge Taylor & Francis, London	2004
2	Introduction To Physical Oceanography	Robert H. Stewart	https://www.uv.es/hegigui/Kasper/por%20Robert%20H%20Stewart.pdf	2007
3	Introduction to physical oceanography	John A. Knauss& Newell Garfield	Waveland Press, Ilinois	2017
4	Practical Handbookof MarineScience	Edited by Michael J. Kennish	CRC Press, London	2001
5	Coastal Submarine Morphology	Guilcher, Andre	Osmania University Library OU_162039	1958
6	Introduction To Coastal Processes & Geomorphology	Gerhard Masselink, Michael Hughes & Jasper Knight	Routledge Taylory& Francis Group , London	2014
7	Tide-InfluencedSedimentary Environments andFacies	P. L. De Boer A. VanGelder AndS.D.Nio	D. Reidel Publishing Company	1988
8	Breaking Ocean Waves: Geometry Structure and Remote Sensing	Eugene A Sharkov	Praxis Publishing, UK	2007

03	Group-2	20GEO13	**Water Recharge Techniques**
Exam Hours: 3 hours		Exam Marks(Maximum):100	

Module-1

Aquifers types and characteristics, Darcy's Law, porosity and permeability, Ground water flow rates & flow directions, general flow equations through porous media. Springs and types. Best practices of groundwater harvesting in different parts of India. Rainwater harvesting and benefits. Importance of water recharge structures. Sources of water for recharge structures. Types of wells and their construction- Open wells, Bore wells, Dug wells, Driven wells, Kalyani Wells, Artesian wells, Keni.

Module-2

General concept & methods of artificial ground water recharge, recharge mounds & induced recharge, wastewater recharge for reuse. Direct surface techniques with Site Characteristic and Design Guidelines: Flooding, Basins or percolation tanks, Stream augmentation, Ditch and furrow system- Lateral Ditch Pattern, Dendritic Pattern, Contour Pattern, Modification of old tanks and wells. Site Characteristics and Design Guidelines: Over irrigation

Module-3

Direct sub surface techniques with Site Characteristic and Design Guidelines: Recharge pits and shafts- Percolation tanks, Injection wells, Dug well recharge, recharge shaft. Borehole flooding. Natural openings, cavity fillings. Hydro-fracturing of wells and bore wells.

Module-4

Combination of surface & sub-surface techniques with Site Characteristic and Design Guidelines: Check Dams, Cement Plug, Nala bunds, Basin or percolation tanks with pit shaft or wells, Gabion structure.

Module-5

Indirect Techniques: Induced recharge from surface water source. Aquifer modification. Ground Water Dams or Sub-Surface Dykes or Underground Bandharas (UGB). Their application in controlling saline water intrusion.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Groundwater	Vijay P Singh, Shalinin Yadav	PublisSpringer Verlag, Singapore	2016

01	GROUP-3	20CGI22	Applications of Geoinformatics in Natural Resources and Environmental Management
Exam Hours:03		**Exam Marks:100**	

Module -1

Concepts of natural resources management: Types of natural resources, renewable, non-renewable, Linkages of natural resources with the economy, impact of natural resources utilization on Earth system functioning, , National Natural Resources Management Systems (NNRMS), Natural Resources Census, Natural Resources Information Systems.

Geological Resources Exploration: Geomorphological Mapping: Mapping geological structures-folds, faults, joints and lineaments, Lithological mapping, Mineral resources mapping and Mineral Resources Information System; encroachment mapping, GIS in mine remediation and mine reclamation

Land Resources Management: Soil survey, soil classification, soil series establishment, profile studies, Land Use Land Cover Mapping, Wetland Mapping, Wasteland Mapping, Land Degradation and Desertification Mapping, Soil Conservation Measures, Soil Erosion Modeling, Land capability Maps, land/ soil irrigability maps and Land Resources Information Systems (LRIS).

Module -2

Agro-ecosystem management: Agro-climatic zonation, Crop Acreage Production Estimation (CAPE), Forecasting Agriculture output through Satellite and Land-based observations (FASAL), Crop norm violation, Cropping systems analysis, RS basis for crop insurance claim. Satellite agro-meteorology; Thermal RS application for crop stress detection, & Microwave application in agriculture, Space inputs for precision agriculture, Agro-climatic planning and information Bank (APIB), Site suitability studies for agricultural crops, horticultural crops. Horticulture, Sericulture, inputs management.

Forest Resources management: Mapping and inventorying of forest resources, Forest biomass estimation, carbon sequestration, forest fire mapping and monitoring, forest fire risk zonation, Biodiversity conservation planning, eco- restoration and eco-development; encroachment mapping and monitoring, Forest Management Plans, and Working Plans. Inputs for preparation of working plan/management plan. Environmental Impact assessment of mining and Industrial activities., Microwave application in Forestry, Wildlife ecology applications Habitat management- wildlife habitat selection, habitat fragmentation, protected areas, Catchments area treatment plans, waste land development, forest plantations and its monitoring, joint forest management, forest resource information system.

Module -3

Water Resources Management: Hydrological cycle, Surface water resources mapping and management; Integrated river basin management, Inter river basin connectivity mapping, river diversion studies, Site suitability for surface storages and hydro-electric power plants, Digital elevation models and their applications, storage yield analysis and reservoir sizing, Floodplain mapping and flood plain zoning, flood mitigation measures, flood water diversion for irrigation. Ground water modeling, preparation of ground water prospecting and recharging maps.

Module -4 Introduction to Environment: Components of environment, biotic and abiotic components, laws of conservation of mass and energy, the basics of thermodynamics, concepts of ecosystem, bio-geo-chemical cycles, ecological pyramids, food webs, energy flow and ecosystem functioning.

Sustainable Development: Concept of sustainability, Integrated Mission for Sustainable Development, Watershed characterization, Acton Plans for Sustainable development, watershed prioritization, developmental impact assessment, Action plans for Sustainable Agriculture and Spacebased Information System for Decentralized

Planning (SIS-DP), Sujala Watershed Project in Karnataka.

Module -5

Water Pollution Applications: Siltation estimation and storage loss estimation, water quality index mapping, point source pollution mapping, non-point source pollution modeling, eutrophication and water vegetation mapping, methane production area mapping and modeling, Modeling of dams and reservoirs for estimation of damage to natural resources, oil slicks tracing and monitoring, sea turbidity and sedimentation mapping, coastal erosion mapping, coastal habitat degradation mapping, ground water contamination studies, Ground water pollution hazard assessment and protection planning using GIS techniques; groundwater quality index mapping.

Air and Atmospheric Pollution Applications: Aerosol remote sensing, air quality indexing and mapping, dynamic air pollution modeling, mapping and measuring troposphere pollutants, environmental sensitivity index mapping; spread and dispersion of smoke plumes from industries and power plants, forest fires, oil wells, etc.

Miscellaneous Applications: RS and GIS Applications in noise pollution and light pollution monitoring. GIS modeling
for bioterrorism, ecology of vectors of epidemics, mapping epidemic vulnerable zones.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

REFERENCE BOOKS:

1. Introduction to Environmental Remote Sensing by Barrett E.C., Curtis, I.F., Chapman and Hall, New York, 1982
2. Remote Sensing principles and Interpretations- Sabins, F.F., (Ed) W.H. Freeman and Co., New York, 1986
3. Remote sensing and Image interpretation - Thomas M. Lillesand and Ralph W. Kiefer, John Wiley and Sons Inc., New York, 1994.

02	GROUP-3	20WLM21	Watershed Planning and Management
Exam Hours:03		**Exam Marks:100**	

Module -1

Watershed concepts: Watershed-Topographic divide, Ground water divide, Stream patterns, Soil erosion- Problems, Types, Conservation technology, Watershed approach, Watershed Management, Factors influencing watershed operations, Watershed characteristics, Deterioration of watershed, Watershed delineation, Prioritizing watersheds, Coding of watershed, Morphometric analysis of watershed-Linear, Areal and Relief aspects, Channel networks, Hypsometric analysis

Module -2

Sediment transport: Sediment-Sources, Mechanics of sediment transport, factors affecting sediment yield, Types of sediment load, Estimation of bed load and suspended sediment load. Estimation of bed load using sampler. Estimation of suspended load, Selection of sediment sampling point, Frequency of sampling, Location of sediment observation post, Collection of sediment samples, Soil loss estimation by USLE, Modified USLE, Revised USLE and other methods. Soil and water: Soil composition, Soil profile and texture, Significance of soil
texture for soil conservation, Infiltration, Soil moisture, Ground water, Soil conditions for plant growth, Essential food elements required for plant growth

Module -3

Land use capability classification: Soil survey, Mapping unit, Purpose of land capability classification, Soil and land use capability-classification, Capability, Limitation; Capability unit; Land capability sub classes, Land capability rating table, Identification of classes in the field, Land use capability classification, Recommended land use and Soil conservation practices for all capability classes. Erosion control measures in agriculture land: Importance, Contour bunding, Drainage of excessive water, Graded bunding, Bench Terracing, Land leveling and grading, grassed waterways.

Module -4

Water conservation and harvesting: Introduction, Water conservation methods for crop land, Treatment of catchments, small storage structures- Water harvesting/silt retention structures, Gully control structures, Small earth dams, spillways, Small weirs, Sand dams, Drought farm pond, Nala-bunding, Off- stream storage, Developing ground water- Recharge and Extraction, Water harvesting for trees and shrubs. Agronomical measures in soil and water conservation: Land use and Conservation agronomy, Grassland Management, Agro-forestry, Horticulture. Erosion control measures in Non-agricultural lands: General- Soil conservation on waste lands, Contour and Staggered trenching, Gully control structures, Sediment retention structure, Retaining walls, Gully and Ravine reclamation

Module -5

Watershed Management: Introduction, Watershed characteristics, Causes and Consequences of watershed deterioration, Objectives, People's participation- Definition, Why to pay incentives, Mobilization of participation, People's organization, Conservation farming, Watershed management plan-General identification of watershed problems, Objectives and Priorities, Socio-economic survey, Watershed map and Preparation of format for watershed management
plan.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

Reference Books

1. Tideman, E. M., "Watershed Management", Omega Scientific Publishers, New Delhi,2002
2. Suresh Rao, Soil and Water Conservation Practices, Standard Publishers, 2003.
3. J. V. S Murthy, Watershed Management, New Age International Publishers, 1998
4. Heathcote, I. W., "Integrated Watershed Management" Springer.
5. Strahler, A. H.,"Modern physical geography", John Wiley & Sons, 1991.
6. V.V. N. Murthy, Land and Water Management, Kalyani Publishers, 1994.

03	Group-3	20GEO14	Basin Analysis – Morphometric and Morphotectonic analysis
Exam Hours: 3 hours			Exam Marks(Maximum):100

Module-1

Definition and scope of basin analysis. Plate Tectonics and Wilson cycle, Main techniques in basin analysis, Control factors in basin-fill : Subsidence, Eustasy. Water shed, Water divider. Basin-Mapping Methods

Module-2

Classification criteria of sedimentary basins, adopted classification, Basins due to lithospheric stretching, Basins due to flexure, Basins associated with strike-slip deformation, Sedimentary basin-fill modelization,

Module-3

Geomorphological parameters of basin analysis, Linear Aspects: Stream Order (Su), Stream Number (Nu) Stream Length (Lu). Bifurcation Ratio (Rb). Weighted Mean Bifurcation Ratio (Rbwm). Mean Stream Length (Lum). Stream Length Ratio (Lurm). Sinuosity Index (Si). Length of Main Channel (Cl). Channel Index (Ci) & Valley Index (Vi). Length of Overland Flow (Lg). Rho Coefficient (ρ)

Module-4

Areal Aspects: Basin Area (A).Length of the Basin (Lb). Basin Perimeter (P).Length Area Relation (Lar). Lemniscate's (k).Form Factor (Ff). Elongation Ratio (Re). Texture Ratio (Rt). Circularity Ratio (Rc). Drainage Texture (Dt). Compactness Coefficient (Cc). Fitness Ratio (Rf). Wandering Ratio (Rw). Watershed Eccentricity (τ). Centre of Gravity of the Watershed (Gc). Stream Frequency (Fs). Drainage Density (Dd). Drainage Intensity (Di). Infiltration Number (If). Drainage Pattern (Dp).

Module-5

Relief Aspects: Relief Ratio (Rhl). Dissection Index (Dis). Ruggedness Number (Rn). Hypsometric Analysis (Hs). Hypsometric Integrals (Hi).

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each

module. ■

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Basin Analysis: Principles and Applications	Philip A. Allen, John R. Allen	Blackwell	2013
2	Fundamentals ofGeomorphology	Richard John Huggett	Taylor & Francis	2002
3	New Perspectives in Basin Analysis	Karen L. Kleinspehn,	Springer Verlag	2012
4	Perspectives in Geomorphology	H S Sharma	Concept Publishing Company New Dalhi	1982
5	Encyclopedia of Geomorphology Vol 1 & 2	Andrew Goudie	Taylor & Francis	2006

04	**GROUP-6**	**20WLM22**	**GROUND WATER HYDROLOGY**
Exam Hours:03			**Exam Marks:100**

Module -1

General Water Balance, Regional Ground Water Balance, Distribution of Subsurface Water, Different Types of Aquifers, Heterogeneity and Anisotropy, Occurrence of Ground Water in Hydro Geological Formations, Structure and Types of Wells. –Problems on estimation of basic parameters.

Module -2

Governing Equation of Groundwater Flow in Aquifers. Derivation of General Differential Equations for Ground Water Flow, Regional Ground Water Problems, Governing Equations for Transient Flow Conditions.

Module -3

Models for Ground Water Analysis: Introduction, Major Applications of Groundwater Models, Numerical Modelling of Groundwater Systems, Groundwater Modelling by the Finite Difference (FD). –Problems. Pollution of Groundwater: Hydrodynamic Dispersion of Pollutants in Groundwater Environment (Advection dispersion, Molecular diffusion) Optimization models for management of groundwater quantity and quality.

Module -4

Well Hydraulics: Analysis of Steady Radial Flow Towards a Well in a confined Aquifer, Dupuit Forcheimmer (DF) Theory of free Surface Flow For Steady Flow in Unconfined Aquifers, Analysis of Steady Radial Flow in Laterlly Stratified Phreatic Aquifers. Problems on well Hydraulics.

Module -5

Artificial Recharge: Spreading methods, Induced-recharge method, Recharge- well method, Subsurface dams, Wastewater discharge, Recharge by urban storm runoff, Case history. Geophysical Methods in Groundwater Exploration, Introduction, Electrical Resistivity Method, Analytical Derivation for Resistivity in Vertical Electrical Sounding, Seismic Retraction Method, Determination of Aquifer Thickness, Geologic and Hydrologic methods, Hydrogeologic well logging, Tracer techniques.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

REFERENCE BOOKS:

1. A. K. Rastogi., Numerical Groundwater Hydrology, Penram International Publishing (India) Pvt.Ltd.2007.
2. Todd D.K. & Mays, L.W., "Ground Water Hydrology", 3 Ed, Wiley.
3. Raghunath H.M., "Ground Water", New Age Publishers, 2007.

01	GROUP-4	20CEE332	Transport processes and modelling of aquatic systems

Exam Hours:03 | **Exam Marks:100**

Module -1

Introduction: Modelling: Introduction, applications in environmental management. Physical phenomena – advection, diffusion, dispersion, Fick's laws of diffusion and convective - diffusion equations for turbulent & shear flow regimes

Module -2

Steady-state water quality modeling: Models for conservative and non-conservative substances. Data collection and analysis specialized water quality surveys, estimation of decay and reareation rates

Module -3

v1-D Oxygen balance models: Streeter-Phelps equation,critical point method. Calibration and verification of 1-D oxygen model. Error measures

Module -4

Mixing zones in rivers: Types of outfalls and mixing regimes. Steady-state 2-D analysis. Field study methodology. Parameter estimation – lateral mixing co-efficient - critical point method – simple numerical problems. Dissolved oxygen models for lakes under completely mixed and stratified conditions

Module -5

Eutrophication models: Simplified nutrient loading models for rivers and lakes. Ocean disposal of wastewater: Siting and design of outfalls. Ground water quality modeling concepts: Formulation 1-D & 2-D models with decay and retardation for instantaneous sources, plume delineation studies

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

REFERENCE BOOKS:

1. Rich L.G., "Environmental Systems Engineering", McGraw Hill.
2. Schnoor J.L., "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley and Sons
3. Thomann R.V., and Mueller J.A., "Principles of Water Quality Management and Control", Harper & Row Publications.
4. Thomann R.V., "Systems Approach to Water Quality Management", McGraw Hill.
5. Lee C.C., and Lin S.D., "Handbook of Environmental Engineering Calculations", McGraw Hill, New York

02	GROUP-4	20WLM321	Wetland Management

Exam Hours:03 **Exam Marks:100**

Module -1

Introduction: History, definition of wetlands, Wetland indicators, Wetland Laws, National wetland inventory, Status and trends of wetlands, The Ramsar Convention.

Module -2

Wetland Classifications: Cowardin's and Hydro geomorphologic wetland classification system. Types and Classification of wetlands (based on Source): Precipitation, surface water and groundwater. Wetland delineation- Technical guidelines, Characteristics and indictors, Methods-preliminary data gathering and synthesis, Selection of methods

Module -3

Wetland Indicators: Wetland Hydrology-Hydrologic cycle, Criteria and field indicators, Kinds of hydrological data,. Wetland recharge and discharge, wetland water budget and balance. **Wetland Soils-** Characteristics, Indicator guidelines, field indicators of Hydric soils, Test indicators of Hydric soils. **Wetland vegetation/ hydrophytes:** Characteristics, indicator guidelines, influencing factors, classification, Functions and values.

Module -4

Wetland conservation and Development: Wetland ecosystems and its environmental significance, Factors affecting wetland habitats. Wetland management-Definition and classification, Wetland values and functions, Wetland degradation and loss, Conservation of wetlands, Wetland management principles. Identifying major problems and Setting objectives and priorities, Management of wetland habitats for ecological processes and wildlife.

Module -5

Wetland Assessment and Monitoring: Natural and constructed wetlands, Managing wetlands for multifunctional benefits, the role of landscape architects in wetlands. Floating Islands-An Alternative to Urban Wetlands and case studies

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

REFERENCE BOOKS:

1. William J. Mitsch, James G. Gosselink, "Wetlands", Published by John Wiley and sons, Inc., Hoboken, New Jersy, Canada
2. Falconer, R. A and Goodwin, P (Ed), "Wetland Management", 1994, Thomas Telford, London.
3. Bruce E. Hammer., "Constructed Wetlands for Wastewater Treatment", 1989, CRC- Press; I Ed.
4. Verhoeven, J.T.A., Beltman, B., Bobbink, R., Whigham, D.F. (Eds.). "Wetlands and natural resource management", Springer-Verlag Berlin Heidelberg, 2006.

(GROUP-4): 20CEE31	**ENVIRONMENTAL IMPACT ASSESSMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Environmental Legislation: Introduction & need, Constitution of India, Environmental Jurisprudence, National Environmental Policy, Environmental Tribunal (Green Tribunal) Legal framework Legislative act, rules, regulations notification and amendments

Module-2

Indian Environmental Acts: Environment (Protection) Act, 1986, Air & Water Acts. Biomedical Waste (Managing and Handling) Rules, 2011, Recycle Plastics (Manufacturing and Usage) Rules, 1999, Water Act, 1974, Air Act, 1981, Forest Act, 1927, Environmental Tribunal Authority, 1995. Wild Life Protection Act, 1972, Biodiversity Rules, 2004

Module-3

Environmental Impact Assessment: Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI. Step-by step procedure for conducting EIA and Limitations of EIA, Prevention of Significant Deterioration (PSD) Programme. Carrying capacity concept

Module-4

Attributes, Standards and Value functions: Public participation in EIA.
Environmental Management Plan (EMP) and Disaster Management Plan (DMP).

Module-5

EIA Case Studies–Thermal Power Plant, Mining, Fertilizer, Construction Projects, Air port, Water and Wastewater Treatment Plants

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Environmental Impact Assessment Methodologies	Anjaneyulu and Valli Manickam	BS Publications, Hyderabad	2010
2	Environmental Impact Assessment	Canter L.	McGraw Hill.	
3	Environmental Impact Analysis-A New Dimension in Decision Making	Jain R.K., Urban L.V., Stacey G.S.	Van Nostrand Reinhold	1977

01	GROUP-5	20CWM11	Numerical Analysis and Advanced Computational Methods

Exam Hours:03	Exam Marks:100

Module -1

Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors.

Mathematical modelling and engineering problem solving:

Simple mathematical model, Conservation Laws of Engineering. (RBT Levels: L2 & L3)

Module -2

Numerical Methods: Partial Differential equation, Newton Raphson method, Finite Difference, Finite Element, method of Characteristics, Different methods, S O R method.

Optimization: Classification and Importance in Environmental Studies, single and multivariate optimization without and with constraints

Module -3

Applied Partial Differential Equations: Classification of second order PDE's, Canonical forms-Hyperbolic, parabolic and Elliptic Equations.

Laplace Transformation method: Transforms of Derivatives, Differential equations and simultaneous equations, Transform of Dirac Delta function, Inverse Transform examples.

Fourier Transform Method: Properties, sine and cosine of
Fourier Transforms.

Module -4

Probability Theory: Review of basic probability theory,Definition of random variables and probability distribution, Probability mass and density function, expaction, moments, central moments, characteristic functions, probability generating and moment generating functions illustrations,Binomial, Poisson, Exponential, Gaussian and Rayleigh distribution examples

Module -5

Joint Probability Distribution: Definition and properties of CDF, PDF, PMF, conditional distributions. Expection, covariance and Correlation. Independent Random variables, statement of central limit theorem - illustrative examples. Random Process: Classification, stationary and ergodic random process. Auto correlation function properties, Gaussian random process.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

REFERENCE BOOKS:

1. Ross S.M.,(1987) "Introduction to Probability and Statistics for Engineers and Scientists", John Wiley Publications.3rd Edition, Academic press.
2. KreyszigErwin(2006),9th Edition" Advanced Engineering Mathematics", Wiley Eastern Publications.
3. Berthouex P M.,and Brown L. C.(1994), "Statistics for Environmental Engineers", Lishe publication, 2nd Edition.
4. Rao. S.S.(1979) Optimization: Theory & Applications Techniques, Wiley Eastern Ltd, New Delhi.
5. TahaH.A.,(2007), "Optimization Research":An introduction, Pear son Prentice Hall, 8th Edition.
6. Shanthakumar M. S., Numerical Methods and Analysis, Tata McGrawHill Publications.

02	GROUP-5	20WLM14	REMOTE SENSING & EOGRAPHICAL INFORMATION SYSTEM
Exam Hours:03		**Exam Marks:100**	

Module -1

1. Remote Sensing:

Remote Sensing Basic Principles: Introduction, Electromagnetic Remote Sensing Process, Physics of Radiant Energy: Nature of Electromagnetic Radiation, Electromagnetic Spectrum**;** Energy Source and its Characteristics, Atmospheric Interactions with Electromagnetic Radiation: Atmospheric properties, Absorption of Ozone, Atmospheric effects on Spectral Response Patterns**;** Energy interactions with Earth's surface materials: Spectral Reflectance Curves; Cossine Law.

Remote Sensing Platforms and Sensors: Satellite System Parameters, Sensor Parameter: Spatial Resolution, Spectral Resolution, Radiometric Resolution**;** Imaging Sensor Systems: Multispectral Imaging Sensor System, Thermal Sensing System, Microwave Imaging Systems; Earth Resources Satellites: Landsat Satellite Programme, SPOT Satellite, Indian Remote Sensing Satellite (IRS)**;** Meteorological Satellites: NOAA Satellite, GOES Satellite.

Module -2

Visual Image Interpretation: Introduction

Digital Image Processing: Introduction, Basic Character of Digital Image, Preprocessing: Geometric Correction Methods, Radiometric Geometric Correction, Atmospheric Geometric Correction**;** Image Enhancement Techniques: Contrast Enhancement**;** Spatial Filtering Techniques: Low Pass Filters, High Pass Filters, Filtering for Edge Enhancement**;** Image Transformations NDVI Transformation, PCA Transformation**;** Image Classification: Supervised Classification, Training Dataset, Unsupervised Classification.

Module -3

Geographical Information System:

Introduction to GIS: Introduction to GIS History of GIS, Early developments in GIS, Applications of

GIS, Spatial Data Input and Editing: Primary Data, Secondary Data, and Data Editing. Introduction: Maps and Map Scale, Map Scale, Type of Maps, Map and Glob

Geo-referencing and Projection: Understanding Earth, Coordinate System, Map Projection, Transformation, Geo-referencing

Module -4

Global Positioning System (GPS): Introduction.

Spatial Database Management Systems: Introduction, Data Storage, Database Structure Models, Database Management system, Entity Relationship Model, Normalization.

Data Models and Data Structures: Introduction, GIS Data Model, Vector Data Structure, Raster Data structure , Geodatabase and Metadata

Module -5

Spatial Analysis: Introduction to spatial analysis, Vector Operations and Analysis, Network Analysis, Raster Data Spatial Analysis. **Interpolation:** Introduction to Interpolation, Global Methods of Interpolation, Local Methods of Interpolation Web GIS: Introduction, Web GIS, OGC & Web Services

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

REFERENCE BOOKS:

1. M. Anji Reddy, 'Remote Sensing and Geographical Information Systems' 4th Edition, BS Publications.
2. Kang-Tsung Chang, 'Introduction to Geographic Information Systems', McGraw-Hill Book Company.
3. Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., 'Geographic Information Systems and Science', 2nd Edition, John Wiley and Sons.
4. Burrough, P. A., and McDonnell, R. A. 'Principles of Geographical Information Systems', Oxford University Press, 2nd Edition.
5. Demers, M. N., 'Fundamentals of Geographic Information Systems', John Wiley & Sons, 3rd Edition.

03	Group-5	20GEO15	Mining Geology
Exam Hours: 3 hours			Exam Marks(Maximum):100

Module-1

Role of geology in mining industry. Definition of mining terms- shaft, hanging wall, adit, roof, drive, cross cut, tunnel, raise, winze, slopes- types. **Methods of mining**- open cast mining (benches, explosives, working slope) and quarrying ;), - Advantages and limitations. Underground/subsurface mining (stoping- open stopes, supported stopes), - Advantages and limitations.

Module-2

Resources classification and Reserves Estimation Methods, Geological plans and sections for orebody evaluation; Exploration drilling, drill core logging and sampling. National Mineral Policy 2019 in brief

Module-3

Geochemical Exploration: Geochemical cycle, Pathfinder and target elements for geochemical exploration. Goldschmidt's classification of the elements and distribution in the Earth – Lithophile, Siderophile, Chalcophile&Atmophile. Geochemical methods of mineral exploration: Procedures for geochemical sampling; Interpretation of geochemical surveys.

Module-4

Geophysical Exploration: General principles and applications of - Magnetic methods, gravity method, electrical methods (direct current resistivity methods), vertical electrical soundings. Interpretation of resistivity curves.Seismic method – Reflection and Refraction.

Module-5

Geological Prospecting Definitions and Principles; Methods of Prospecting; Methods of Sampling: theory and methods; Geological plans and sections for orebody evaluation.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Courses in Mining geology	Arogyaswamy, R.N.P	CBS Publishers and Distributors Pvt.Ltd.	2019
2	Fundamentals of Geophysics.	WILLIAM LOWRIE	Cambridge University Press	2007
3	Introduction To Geochemistry Principles And Applications	Misra K.C.	Wiley India	2005
4	Exploration and mining geology	Peters, William C.	New York: Wiley, c1978.	1978
5	Geophysics: A Very Short Introduction	William Lowrie ·	Oxford	2018
6	Advances In Geophysics	H. E. LANDSBERG & J. VAN MIEGHEM	Academic Press, New York	1974

04	GROUP-1	20WLM333	Global Warming and Climate Change
Exam Hours: 03			**Exam Marks: 100**

Module 01:

Introduction: Introduction and history of meteorology and climatology: The atmosphere, Solar energy, Global circulation, , Climatology, Mid-latitude disturbances , The polar regions, Tropical weather, Paleoclimates, The global climate system

Atmospheric composition, mass and structure

Composition of the atmosphere: Primary gases, Greenhouse gases, Reactive gas species, Aerosols, Variations with height, Variations with latitude and season, Variations with time

Mass of the atmosphere: Total pressure, Vapor pressure

Module-2

Atmospheric composition, mass and structure

The layering of the atmosphere: Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere and magnetosphere

Solar radiation and the global energy budget : Solar radiation : Solar output, Terrestrial infrared radiation and the greenhouse effect, Heat budget of the earth

Atmospheric moisture budget : The global hydrological cycle, Humidity, Evaporation, Condensation, Precipitation characteristics and measurement

Module-3

Numerical models of the general circulation, climate and weather prediction

Fundamentals of the GCM, Model simulations: GCMs, Simpler models, Regional models, Data sources for forecasting, Numerical weather prediction: Short- and medium- range forecasting, Nowcasting, Long-range outlooks

Module-04

Boundary layer climates: Surface energy budgets, Non-vegetated natural surfaces : Rock and sand, Water, Snow and ice Vegetated surfaces: Short green crops, Forests

Urban surfaces: Modification of atmospheric composition, Modification of the heat budget, Modification of surface characteristics, Tropical urban climates.

Module-05

Climate change: General considerations, Climate forcing, feedback and response : Climate forcing, Climate feedbacks, Climate response, The importance of framework

The climatic record : The geological record, The last glacial cycle and post- glacial conditions, The past 1000 years

Understanding recent climatic change : Circulation changes, Solar variability, Volcanic activity, Anthropogenic factors

Projections of temperature change through the twenty-first century : Applications of General Circulation Models, The IPCC simulations **Projected change in other system components :** Hydrologic cycle and atmospheric circulation, Global sea level, Snow and ice, Vegetation, Post-scrip

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Barry R.G., and Chorley R.L., "Atmosphere, Weather and Climate", 4th Edition, ELBS Publication.
2. Bolin B., (Ed.), "Carbon Cycle Modelling", John Wiley and Sons Publications.

Reference Books:

1. Srivatsava A.K., "Global Warming", APH Publications.
2. Wyman R.L., (Ed.), , "Global Climate Change and Life on Earth", Chapman and Hall Publications.
3. Yadav, Chander and Bhan, "Global Warming: India's Response and Strategy", RPH Publications.

01	GROUP-6	20CWM322	Human Impact On Marine and Coastal Environment

Exam Hours:03	Exam Marks:100

Module -1

Estuaries and Saltwater Marshes; Adaptations of Estuarine and Saltwater Organisms – Sea-grass Ecosystem – Mangrove Ecosystem – Barrier Islands, Biogeography – Coral **Reefs and Atolls** – Open Ocean – Marine Benthos and Tidal Communities – Human Impact on the Marine Environment

Module -2

Coastal Hazard: Coastal Hazard; Natural vs. Man-made hazard - Cyclones, Coastal Erosion, Tsunami, Flood, Storm surges, Sea Level Rise and Others – Impacts on Natural and Human environment.

Module -3

The Human Coast The Human Coast - Governance of the Coast: Institutions, Policy and Jurisdictions – Technological Hazards - Biological and Anthropogenic Coastal Hazards - Hazards and Disasters; Definition, Causes, Effects, Differences and their relationship to each other.

Module -4

Case Studies Examples – Case Studies – Lessons Learnt – Preparing for the Future growth.

Module -5

Coastal Hazard Management Ethical Dimensions - Competing Values - Growth Management: tools, plans, principles – Mitigation: Definition, approaches, types and examples - Coastal Hazards Management Framework -
Hazard Mitigation Planning

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

REFERENCE BOOKS:

- Barnes, R.S.K. and Hughes, R.N.. Introduction to Marine Ecology, 3rd ed., Blackwell Publishing, 1999.
- Beatley, T., David, J.B. and Anna, K.S. An Introduction to Coastal Zone Management, Island Press, Washington D.C., 2002.
- Bryant, E., Natural Hazards, Cambridge University Press, New York, 2006.
- Burby, R.J., ed., Cooperating With Nature: Confronting Natural Hazards With Land-Use Planning for Sustainable Communities, Joseph Henry Press, Washington D.C. 1998.)
- Godschalk, D.R., et al., , Natural Hazard Mitigation: Recasting Disaster Policy and Planning, Island Press, Washington D.C,1999.
- NC Division of Emergency Management, Hazard Mitigation Section, Risk Assessment and Planning Branch, Keeping Natural Hazards From Becoming Disasters: A

Mitigation Planning Guidebook for Local

- Governments, 2003

02	Group-6	20GEO16	Petroleum Geology and Sedimentary Basins of India
Exam Hours: 3 hours			Exam Marks(Maximum):100

Module-1 :

Petroleum Geology Theories of Origin of petroleum – On organic and organic theory. Physical & Chemical properties/composition of petrolum (Crude oil and gas), Alkanes, cyclo Alkenes/Naphthenes, Aromatics,Asphaltenes. Petroleum refining & Products. Origin of petroleum .Definition of Petroleum system and elements of petroleum system.

Module-2 :

Evolution of Sedimentary Basins &Petroliferous Basins of India : Plate tectonics and basin evolution;Wilson cycle. Simple Classification of sedimentary basins based on the tectonic setup.

Brief descriptions of Petroliferous basins of India: Bombay offshore basin, Assam shelf, Cambay Basin, Rajasthan, Krishna Godavari, Basin, Cauvery and Assam-Arakan Fold Belt.

Module-3 :

Petroleum Exploration Introduction to geophysical methods in petroleum exploration (Gravity, magnetic and Seismic). Application of Sequence, stratigraphy, Seismic stratigraphy and Biostratigraphy in petroleum exploration.

Petroleum geochemistry. Basic Seismic Data acquisition (2D & 3D), processing, and Interpretation. Drilling of a Well (Onshore and offshore) general principles. Data acquisition plan in exploration well. Casing andCementaion. Basic understanding of Drilling fluids and types. Rock cutting studies, Coring and core analysis, Mud logging Formation evaluationPetrophysical properties of rocks, Well logging and reservoir parameters.

Module-4:

Petroleum Reservoirs and Bio-fuel energy resources: Oil and gas bearing Source Rocks, Reservoir Rock, Traps and types of traps (folds, diapirs or salt domes), Cap rocks (Seals) & over burden rock. Process of Source rock maturation, hydrocarbon generation, Migration and Accumulation

Module-5 :

Unconventional Oil & Gas: Basic definition of what is Unconventional deposits. Unconventional Liquid hydrocarbons (Tight Oil, Heavy Oil, Oil sands, Oil shale and shale oil). Unconventional Gaseous hydrocarbon deposits: Shale Gas, Coal Bed methane (some coal bed methane blocks and production from India). Introduction to Biofuels. Biofuels as renewable energy resources. Bio-fuel technology.Gas hydrates occurrence and origin; Structure of gas hydrate, Types of gas hydrate; Geological setting of Hydrate; Stability of gas hydrates; Gas hydrate reservoir

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

	Title of the book	Author Name	Publisher's Name	Publication year
1	Sedimentary Basins of India: Tectonic Context	by S.K. Tandon	Charu Pant (Editor)	1991
2	Basins, categories and Petroliferous basins of India and basin information	http://dghindia.gov.in/index.php/page?pageId=66&name=Indian%20Ge	DGH website	2020
3	Petroleum geoscience	Gluyas& Swarbrick	Blackwell Publishing	2003
4	Elements of Petroleum geology	Richard Shelly & Stephen Sonnenberg	Elsevier , Academic press	2015
5	Petroleum Engineering: Principles & Practice	CG Wall & Archer JS	Springer Netherlands	1986
6	Basic Petroleum Geology and Log Analysis	Halliburten		2001
7	geology and geochemistry of oil and gas	G.V. Chilingar, L.A. Buryakovsky, N.A. Eremenko & M.V. Gorfunkel	Elsevier, London	2005

03	GROUP-2	20WLM331	Ground Water Assessment, Development & Management
Exam Hours:03		**Exam Marks:100**	

Module -1

Zones of Aeration and Saturation: Zone of aeration, Zone of saturation, Storage efficient of aquifers, Fluctuations of the water table, Fluctuations of the piezometric surface, Recharge and discharge areas.

Ground Water Flow: Properties of water in relation to flow, Head distribution, Laminar and turbulent flow, Darcy's law. Formation constants, Flow through aquifers.

Module -2

Evaluation of Aquifer Properties: Aquifer tests, Confined aquifers, Semiconfined aquifers, Unconfined and semiunconfined aquifers, Transition for artesian to water table conditions, Bounded aquifers, Partially penetrated aquifers, Sloping piezometric and phreatic surfaces, Areal methods. Sea Water Intrusion: Sea Water Intrusion in Coastal Aquifers, Modelling of Pollutant Transport in the Unsaturated Zone. Prevention and Control of Seawater Intrusion.

Module-3

Ground Water Recharge, Discharge and Balance: Parameters of Ground- Water Balance, Estimation of Recharge Components, Nuclear Methods, Estimation of Ground Water Discharge, Ground Water Resources Evaluation In India, Case History

Module-4

Ground Water Development and Management: Ground-Water Development, Water logging, Conjunctive use, Desalination, Modelling Techniques in Ground-Water Management, Ground Water Legislation.

Management of Groundwater: Pollution in Relation to water use, Municipal sources and causes, Industrial sources and causes, Agricultural sources and causes, Miscellaneous sources And causes, Attenuation of Pollution, Monitoring Groundwater Quality

Module-5

Groundwater Basin Management and Conjunctive Use: Groundwater Basin Management, Conjunctive Use, Mathematical modelling of a dual aquifer system

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. K. R. Karanth, Ground Water Assessment Development and Management, Tata McGraw- Hill Publishing Company Limited, New Delhi.1.

Reference Books:

1. David Keith Todd, Groundwater Hydrology, Gopsons Paper Ltd., Noida, Second Edition.
2. H. M. Raghunath, Ground Water, New Age International (P) Ltd., New Delhi, Third Edition.

02	**GROUP-3**	**20CEE31**	**Environmental Impact Assesment**
Exam Hours:03		**Exam Marks:100**	

Module -1

Environmental Legislation: Introduction & need, Constitution of India, Environmental Jurisprudence, National Environmental Policy, Environmental Tribunal (Green Tribunal) Legal framework Legislative act, rules, regulations
notification and amendments

Module -2

Indian Environmental Acts: Environment (Protection) Act, 1986, Air & Water Acts. Biomedical Waste (Managing and Handling) Rules, 2011, Recycle Plastics (Manufacturing and Usage) Rules, 1999, Water Act, 1974, Air Act, 1981, Forest

Act, 1927, Environmental Tribunal Authority, 1995. Wild Life Protection Act, 1972, Biodiversity Rules, 2004

Module -3

Environmental Impact Assessment: Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI. Step-by step procedure for conducting EIA and Limitations of EIA, Prevention of Significant Deterioration (PSD) Programme. Carrying capacity concept

Module -4

Attributes, Standards and Value functions: Public participation in EIA. Environmental Management Plan (EMP) and Disaster Management Plan (DMP).

Module -5

EIA Case Studies –Thermal Power Plant, Mining, Fertilizer, Construction Projects, Air port, Water and Wastewater Treatment Plants

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

Reference Books

1. Anjaneyulu and Valli Manickam, (2010), "Environmental Impact Assessment Methodologies", BS Publications, Hyderabad.
2. Canter L., “Environmental Impact Assessment”, McGraw Hill.
3. Jain R.K., Urban L.V., Stacey G.S., (1977), "Environmental Impact Analysis-A New Dimension in Decision Making", Van Nostrand Reinhold