Visvesvaraya Technological University, Belagavi.

PhD Coursework Courses – 2018 (Geology)

As per 2017 Regulation

Group-1		
Sl. No.	**CODE**	**NAME OF THE SUBJECT**
1	16CGI12	Fundamentals of remote Sensing
2	16WLM424	Global Warming and Climate Change
3	16CEE1154/16CWM154	Remote sensing and GIS in environmental engineering

Group-2		
Sl. No.	**CODE**	**NAME OF THE SUBJECT**
1	16CGI11	Fundamentals of Geostatistics
2	16WLM422	Groundwater Assessment, Development & Management
3	16WLM12	Surface Water Hydrology

Group- 3		
Sl. No.	**CODE**	**NAME OF THE SUBJECT**
1	16CGI22	Applications of Geoinformatics in Natural Resources and Environmental Management
2	16CEE22	Ecology and environmental Impact assessment
3	16WLM21	Watershed Management

Group-4		
Sl. No.	**CODE**	**NAME OF THE SUBJECT**
1	16CEE253	Transport processes and modeling of aquatic systems
2	16WLM421	Wetland management

Group-5		
Sl. N.	**CODE**	**NAME OF THE SUBJECT**
1	16CWM11	Advanced Computational Methods and Numerical Analysis
2	16WLM14	Remote Sensing & GIS

Group-6		
Sl. No.	**CODE**	**NAME OF THE SUBJECT**
1	16WLM24	Ground Water Hydrology
2	16CWM424	Human impact on Marine and Costal Environment

Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Geology)
As per 2017 Regulation

01	16CGI12	GROUP-1	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

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02	16WLM424	GROUP-1	Global Warming and Climate Change
Exam Hours:03		**Exam Marks:100**	

Module -1 Introduction: Radiative forcing, Earth Albedo, Irradiance, Energy budget. Scientific principles- warming earth and Principle of thermodynamics.

Module -2 Green-House Effect as a Natural Phenomenon, Green House Gases GHGs) and their Emission Sources and sinks of C02, Methane, Nitrous oxides, carbon cycle disequilibrium, Global Warming Potential (GWP) of GHGs Characterization & Classification of atmospheric pollutants,–description and application of point, line and areal sources.

Module -3 Climate change- Climate change trends. Components of climate change process, Ozone layer depletion and its control,
Impacts of climate change: Global and India, Temperature Rise, Sea Level rise, Coastal Erosion and landslides, Coastal Flooding, Wetlands and Estuaries loss Impact of ocean current on global climate, EL-NINO & LA-NINA effects

Module -4. **Kyoto Protocol:** Importance, Significance and its role in Climate Change
Carbon Trading - Mechanisms, Various Models (Indian) Global and Indian Scenario

Module -5 Cleaner Development Mechanisms: Various Projects related to CO2 Emission Reduction. **Alternatives of Carbon Sequestration:** Conventional and non-conventional techniques , Role of Countries and Citizens in Containing Global Warming

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. Barry R.G., and Chorley R.L., “Atmosphere, Weather and Climate”, 4th Edition, ELBS Publication.
2. Bolin B., “Carbon Cycle Modelling”, John Wiley and Sons Publications.
3. Corell R.W., and Anderson P.A., “Global Environmental Change”, Springler Verlog Publishers.
4. Francis D., “Global Warming: The Science and Climate Change”, Oxford University Press.
5. Frame B., Medury Y., and Joshi Y., “Global Climate Change: Science, Impact and Responses”.
6. Linden E.,, “The Winds of Change: Climate, Weather and the Destruction of Civilizations”, Simon and Schuster Publications.
7. Mintzer I.M.,“Confronting Climate Change, Risks, Implications and Responses”, Cambridge University Press.
8. Srivatsava A.K., “Global Warming”, APH Publications.
9. Wyman R.L., “Global Climate Change and Life on Earth”, Chapman and Hall Publications. 10. Yadav, Chander and Bhan, “Global Warming: India’s Response and Strategy”, RPH Publications.

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As per 2017 Regulation

03	16CEE1154/ 16CWM154	GROUP-1	Remote sensing and GIS in environmental engineering
Exam Hours:03		**Exam Marks:100**	

Module -1 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 -4 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 -5 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:

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

Reference Books:

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

Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Geology)
As per 2017 Regulation

01	16CGI11	GROUP-2	Fundamentals of Geostatistics
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

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PhD Coursework Courses – 2018 (Geology)
As per 2017 Regulation

02	16WLM422	GROUP-2	Groundwater 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.

References Books:

1. K. R. Karanth, Ground Water Assessment Development and Management, Tata McGraw-Hill Publishing Company Limited, New Delhi.1.
2. David Keith Todd, Groundwater Hydrology, Gopsons Paper Ltd., Noida, Second Edition.
3. H. M. Raghunath, Ground Water, New Age International (P) Ltd., New Delhi, Third Edition.

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PhD Coursework Courses – 2018 (Geology)
As per 2017 Regulation

03	16WLM12	GROUP-2	Surface Water Hydrology
Exam Hours:03		**Exam Marks:100**	

Module -1 Introduction: Scope and importance of hydrology, Hydrologic cycle, Global and India's Water resources, Applications of hydrology. Watershed concept and modeling: Catchment-topographic and ground water divide, stream patterns, Description of the catchment, catchment processes, demarking a catchment, water budgeting, Classification of models, model formulation, Lumped parameter conceptual models, Physically based models, Model performance testing. Precipitation:-Transitory systems favoring precipitation, Formation of precipitation, Climate and Weather seasons in India.

Module -2 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. Abstractions from precipitation: Evaporation-Process, measurement, empirical equations and Estimation by water budget method and Energy budget method.

Module -3 Evapo-transpiration-AET & PET, Estimation by Penman's equation, Reference Crop Evapo-transpiration by Blaney Criddle formula, Infiltration-Process, Measurement, Horton's equation and Philip's equation. Infiltration indices, measurement factor affecting infiltration. Probability and Statistics-Introduction, Probability and Random variables, PDF and CDF, Distribution functions, Selection of distribution function and its parameter estimation. Correlation, Regression analysis-Simple linear and multiple linear regression, curvilinear regression. F test and t- tests. Runoff:-Process, Factors affecting runoff, API, Basin yield, Curve number method.

Module -4 Hydrograph and its features, hydrograph separation methods, Unit hydrograph and its derivation, Unit hydrographs from complex storms and for various durations, Use of S curve, Synthetic unit hydrograph.

Module -5 Flood: Design flood and its estimation- Rational method, Frequency analysis Gumbel's and Log-Pearson's type III distribution, Risk and Reliability, 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 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. Linsley R K, Kohler and Paulhus, "Hydrology for Engineers", McGraw Hill, NY, USA,1958.
2. Mutreja, K. N., "Applied hydrology", Tata McGraw Hill Pub. Co., New Delhi, India-1986.
3. Chow, V.T., "Handbook of Applied hydrology", McGraw Hill, NY, 1964
4. Singh, V. P., "Elementary Hydrology", Prentice Hall, 1992
5. Subramanya K., "Engineering Hydrology", Tata McGraw Hill, 1998
6. Jaya Rami Reddy, P., "A text book of Hydrology", Laxmi publications,2009
7. Putty, M. R.Y., "Principles of Hydrology", I.K. Int. Publishing House, New Delhi,2010

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01	16CGI22	GROUP-3	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.

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02	16CEE22	GROUP-3	Ecology and environmental Impact assessment
Exam Hours:03		**Exam Marks:100**	
Module -1 Ecology: Classification of Ecosystems, Structure and Function of Ecosystems, Energy flow in Ecosystems, Ecological Niche and succession, Bio-geo-chemical cycles, Ecological Pyramids.			
Module -2 Aquatic and Terrestrial Ecosystems: Diversity and dominance Indices, Ecosystem Models. Climate change and biodiversity Lake Ecosystem: Trophic levels, nutrient loading, nutrient enrichment, Leibig's Law, control of eutrophication.			
Module -3 Environmental Impact Assessment: Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI. Step 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:. in EIA. Environmental Management Plan (EMP) and 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. Kormondy, "Concepts of Ecology", Prentice Hall Publication, New Jersey. 2. Odum, "Fundamentals of Ecology", Adisson Co. 3. Krebs J., "Ecology - The Experimental Analysis of Distribution and Abundance", I Edition, Harper International. 4. Hall C.A.S., and Day J.W., "Ecosystem Modeling in Theory and Practice: An Introduction with Case Histories", John Willey. 5. Canter L., , "Environmental Impact Assessment", McGraw Hill.			

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03	16WLM21	GROUP-3	Watershed 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, Peoples involvement, Watershed approach, Watershed Management, Factors influencing watershed operations, Small and Large watersheds, 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, Incipient motion, Types of sediment load, Estimation of bed load and suspended sediment load. Estimation of bed load using sampler. Selection of sediment sampling point, Frequency of sampling, 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 process and rate, Soil moisture condition, Ground water availability, 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, Identification of classes in the field, Land use capability classification, Recommended land use and conservation practices for all capability classes. Erosion control measures in agriculture land: Importance, Contour bunding, Surplussing structures, 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 Practices: Introduction to watershed characteristics, Objectives, People's participation- Importance, Incentives and why to pay incentives, Mobilization of participation, People's organization, Conservation farming, Watershed management planGeneral 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. J. V. S Murthy, Watershed Management, New Age International Publishers, 1998.
3. Suresh Rao, Soil and Water Conservation Practices, Standard Publishers, 2003.
4. V.V. N. Murthy, Land and Water Management, Kalyani Publishers, 1994.
5. Heathcote, I. W., "Integrated Watershed Management" Springer. 6. Strahler, A. H.,"Modern physical geography", John Wiley & Sons, 1991.

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PhD Coursework Courses – 2018 (Geology)
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01	16CEE253	GROUP-4	Transport processes and modeling of aquatic systems
Exam Hours:03		**Exam Marks:100**	
Module -1 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 1-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. Thomann R.V., and Mueller J.A., "Principles of Water Quality Management and Control", Harper & Row Publications. 3. Schnoor J.L., "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley and Sons. 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.			

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02	16WLM421	GROUP-4	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.

References:

1. William J. Mitsch, James G. Gosselink, "Wetlands", Published by John Wiley and sons, Inc., Hoboken, New Jersy, Canada
2. Gail Brooks, Jon A. Kusler, "Wetland Hydrology", Association state wetland managers.
3. Falconer, R. A and Goodwin, P (Ed), "Wetland Management", 1994, Thomas Telford, London.
4. Bruce E. Hammer., "Constructed Wetlands for Wastewater Treatment", 1989, CRC-Press; I Ed.
5. J.T.A. Verhoeven., "Wetlands and natural resource management".

Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Geology)
As per 2017 Regulation

01	16CWM11	GROUP-5	Advanced Computational Methods and Numerical Analysis
Exam Hours:03		**Exam Marks:100**	

Module -1 Numerical Methods: Partial differential equation, Newton Raphson Method, Finite Difference, Finite element, method of characteristics, different methods, successive over relaxation method. Optimization: Classification and Importance in Environmental studies. Single and multivariable optimization without and with constraints.

Module -2 Linear Programming: Different methods, linear approximation of non-linear optimization. Statistics: Significance test, Frequency distribution, characteristics of distribution, Method of least squares and regression, Multiple regression.

Module -3 Applied Partial Differential Equations: Classification of second order partial differential equations, Canonical forms - Hyperbolic, Parabolic, Elliptical Equations. Laplace Transform Method: Transforms of derivatives, Differential equations and simultaneous equations. Transform of Dirac Delta function, Inverse Transform - examples. Fourier Transform Method: Properties of Fourier Transforms, Sine and Cosine Fourier Transforms.

Module -4 Probability Theory: Review of basic probability theory. Definition of random variables and probability distribution, Probability mass and density funstion, expaction, moments, central moments, charectaristic 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.

Text Books:

1. Ross S.M.,(1987) “Introduction to Probability and Statistics for Engineers and Scientists”, John Wiley Publications.3rd Edition, Academic press.
2. Kreyszig Erwin(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.

Reference Books:

1. Rao. S.S.(1979) Optimization: Theory & Applications Techniques, Wiley Eastern Ltd, New Delhi.
2. Taha H.A.,(2007), “Optimization Research”:An introduction, Pear son Prentice Hall, 8th Edition
3. Shanthakumar M.S., Numerical Methods and Analysis, Tata McGrawhill Pubs.

Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Geology)
As per 2017 Regulation

02	16WLM14	GROUP-5	Remote Sensing & GIS
Exam Hours:03		**Exam Marks:100**	

Module -1 1. Remote Sensing: Introduction: Types of remote sensing with respect to wavelength regions; active and passive remote sensing. Platforms: Types of platforms - airborne remote sensing, space borne remote sensing; Atmospheric condition and altitude; Attitude of platform. Physics of Remote Sensing: Electromagnetic spectrum, Characteristics of electromagnetic radiation; Interactions between matter and electro - magnetic radiation; Wavelength regions of electro - magnetic radiation. Black body radiation; Reflectance; spectral reflectance of land covers; Spectral characteristics of solar radiation; energy interaction in the atmosphere; energy interactions with the earth's surface - spectral reflectance curves.

Module -2 Image Interpretation and Analysis: Remote sensing data formats; Techniques of visual interpretation. 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 -3 2. 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 Geo-referencing and Projection: Understanding Earth, Coordinate System, Map Projection, Transformation, Geo-referencing.

Module -4 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.

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.

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. Kang-Tsung Chang, 'Introduction to Geographic Information Systems', McGraw-Hill Book Company.
2. M. Anji Reddy, 'Remote Sensing and Geographical Information Systems' 4th Edition, BS Publications.
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.

Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Geology)
As per 2017 Regulation

01	16WLM24	GROUP-6	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.

Visvesvaraya Technological University, Belagavi.
PhD Coursework Courses – 2018 (Geology)
As per 2017 Regulation

02	16CWM424	GROUP-6	Human impact on Marine and Costal Environment
Exam Hours:03		**Exam Marks:100**	

Module -1 Estuaries and Saltwater Marshes – Adaptations of Estuarine and Saltwater Organisms – Seagrass 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: What is a 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.

Text Books:

1. Barnes, R.S.K. and Hughes, R.N.. Introduction to Marine Ecology, 3rd ed., Blackwell Publishing, 1999.
2. Beatley, T., David, J.B. and Anna, K.S. An Introduction to Coastal Zone Management, Island Press, Washington D.C., 2002.
3. Bryant, E., Natural Hazards, Cambridge University Press, New York, 2006.
4. Burby, R.J., ed., Cooperating With Nature: Confronting Natural Hazards With Land-Use Planning for Sustainable Communities, Joseph Henry Press, Washington D.C. 1998.)

Reference Books:

1. Godschalk, D.R., et al., , Natural Hazard Mitigation: Recasting Disaster Policy and Planning, Island Press, Washington D.C,1999.
2. 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.