M.Tech (Geoinformatics)

Course Structure (revised with effective from July 2018)

I Semester
5 Core Courses + 4 Labs 18 credits

II Semester
2 Core Courses + 3 Elective courses + 3 Labs 18 +2 =20 credits

III Semester
Mini Project & Scientific Writing + Comprehensive Viva+ Thesis Phase 1 17 credits

IV Semester
Thesis Phase 2 15 credits

Total Credits: 70 (same as other M.Techcourses of IIST)

Credits Breakup:

Taught courses: 10 courses (9 - 3 credits courses + 1 - 2 credit course)+ 7 labs (1 credit each) = 36 credits

Comprehensive viva and mini project: 5 credits
Geospatial outreach : 2 credits
Thesis 27 credits

Eligibility for Admission

(a) B.E. / B.Tech in CSE/ IT/EEE/ ECE, Civil, Physical sciences/ Engineering Physics/ Geoinformatics/Agricultural Engineering or M.Sc in Mathematics/Physics

(b) Valid GATE score
## Course Curriculum
### Sem-1

<table>
<thead>
<tr>
<th>S.No</th>
<th>Course title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ESG611 Introduction to Remote Sensing and Image Analysis</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>ESG612 Geographic Information System</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>MA812 Mathematical Methods</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>ESG664 Photogrammetry</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>ESG616 Scientific Computing for Geospatial Data Analysis</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>ESG631 Remote Sensing and Image Analysis Lab</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>ESG632 Geographic Information System Lab</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>ESG633 Photogrammetry Lab</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>ESG634 Scientific Computing for Geospatial Data Analysis Lab</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total credits 18**

(L-Lecture  T-Tutorial  P-Practical  C-Credit)

### Sem-2

<table>
<thead>
<tr>
<th>S.No</th>
<th>Course title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ESG624 Pattern Recognition and Machine Learning</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>ESG625 Analysis and Modelling of Geospatial data</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Elective-1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Elective -2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Elective -3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>ESG643 Pattern Recognition and Machine Learning Lab</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>ESG644 Analysis and Modelling of Geospatial data lab</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>ESG645 Elective lab</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>ESG655 Geospatial outreach (during summer break)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

**Total credits 18+2 (summer break)**
## Elective Courses

<table>
<thead>
<tr>
<th>S.No</th>
<th>Course Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Satellite based positioning and LiDAR remote sensing</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Advanced GIS</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Hyperspectral image processing and analysis</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Computer vision and advanced image processing</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Microwave remote sensing</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Remote sensing and GIS for environmental and natural resource management</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Remote sensing and GIS for atmospheric sciences and ocean studies</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Quantitative remote sensing</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
SYLLABUS

Semester– I

ESG611 Introduction to Remote Sensing and Image Analysis (3 – 0 – 0) 3 credits

Electromagnetic radiation and its interaction with matter, Spectral signatures, image formation remote sensors and platforms, resolutions, radiometric and geometric distortions, thermal remote sensing, spectral indices, classification techniques, image transformations, intensity transformations, spatial filtering, image formats, noise reduction, image segmentation.

Textbook

2. Remote Sensing and Image Interpretation (5 th Ed.) by Thomas M. Lillesand, and Ralph W. Kiefer, John Wiley & Sons Ltd.

References

ESG612 Geographic Information System (3 - 0 - 0) 3 credits


Textbook

MA812 Mathematical Methods (3-0-0) 3

Linear Algebra: n- dimensional Euclidean spaces, linear transformation, Matrices, Eigen values and Eigen vectors, Generalised inverses, SVD.


Optimization Techniques: Maxima and Minima of functions of several variables, saddle point, Lagrange Multipliers, Steepest- Descent method.


Sampling theory :Central Limit Theorem, Difference Between Two Sample Proportions, Sample Mean and Variance, Sample Proportion, Sampling Distributions, Sampling Procedures, Statistics for Normal Random Variables, Confidence interval, Testing of Hypothesis, Goodness of fit.

Text Books

Suggested Reference Books
3) K B Datta: Matrix and Linear Algebra.

ESG 664 Photogrammetry(3-0-0) 0 credits

Introduction: Basics of geometrics, Projection and coordinate system, Camera calibration - representation of digital images B/W, RGB, HIS, CCD cameras, time delay integration, spectral sensitivity of CCD sensor, geometry problem of CCD image - , image measurement, coordinate system, image movement, image transformation, geometric and radiometric transformation - Vertical aerial photographs: Parallax, Stereo model - Tilted photos: Rectification, Mathematical photogrammetric principles, Analog vs Analytical vs Digital models - Orientation: Interior, Relative, Absolute - Collinearity and Coplanarity - Image matching - Ground control - Aerotriangulation - ortho photo generation, digital elevation model, SAR Interferometry, LASER mapping - automated mapping, feature extraction, image enhancement, virtual reality modeling, non-topographic Photogrammetry, video metrology

Textbooks

ESG616 Scientific Computing for Geospatial Data Analysis(2-0-0) 2 credits
Programming in the context of processing of raster, vector and tabular geospatial data. Basic principles of programming, including languages and syntax, paradigms, variables, control flow and functions. IDL, python, and R. Image spatial data structures - and spatial databases – Structured query language- ADT, spatial ADTs and their operations, Spatial data structures and spatial indexing.

References

SEMESTER- II

ESG 643 Pattern Recognition and Machine Learning (3-0-0) 3 credits

Kernel Methods: Introduction to metric space, vector space, normed space, inner product space; RKHS; Learning theory; SVM for classification & regression; implementation techniques of SVM; kernel ridge regression; kernel density estimation; kernel PCA; kernel online learning, Random forest, Genetic algorithms, ant colony optimization Spectral Clustering; model based clustering, Expectation Maximization; Independent Component Analysis; Hidden Markov models; Factor Analysis; introduction to Graphical models & Sampling Methods.
Basic concepts of machine learning, inductive learning, decision tree learning, semi-supervised learning, ensemble learning, clustering, artificial neural networks, support vector machines, bayesian learning, deep learning, Convolution neural network, accuracy assessment

Text books:
3. Neural Networks and Learning Machines (3rd Ed) by Simon Haykin, McMaster University, Canada, 2008.

References
1. Pattern Recognition and Machine learning Christopher M Bishop 2006
ESG644 Analysis and Modelling of Geospatial Data (3-0-0) 3


References:

Elective Courses

ESG666 Satellite based positioning and LiDAR Remote Sensing (3-0-0) 3 credits

Development of global surveying techniques, positioning and navigation with satellites, Reference systems: coordinate systems, time systems, satellite orbits: orbit description, orbit determination, orbit dissemination, satellite signals GPS – reference systems, GPS services, GPS segments, GPS signal structure, GLONASS - reference systems, GLONASS segments, GLONASS signal structure, Galileo - reference systems, Galileo services, Galileo segments, Galileo signal structure, IRNSS - signals, services and segments, satellite based augmentation systems (SBAS) - GAGAN, WAAS, EGNOS, MSAS applications.

Introduction to LiDAR, LIDAR system components, characteristics of LIDAR data, LIDAR remote sensing platforms-airborne platforms, spaceborne platforms, ground-based platforms, bathymetric mapping systems, registration of LIDAR data, LIDAR filtering, DTM generation, point cloud processing, building extraction, forestry- LIDAR and forests, measuring forests with LIDAR, basic forest metrics, 3D urban modelling, mobile LIDAR mapping, fusion with other sensors

Textbook
5. LiDAR Remote Sensing and Applications Pinliang and Qi Chen 2018 CRC Press
Advanced GIS(3-0-0) 3 credits


Text Books
2. Geographic Information Systems and Science by Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind, John Wiley & Sons Ltd.

ESG665 Hyperspectral image processing and analysis(3-0-0) 3 credits

Reflectance spectroscopy, dimensionality reduction, feature selection, subspace modelling, endmember extraction, hyperspectral band ratios and vegetation indices, hyperspectral classification methods, target detection, spectral unmixing, spectral libraries, applications of hyperspectral remote sensing

Textbook
2. Hyperspectral Data Exploitation: Theory and Applications by Chein-I Chang, Wiley & Sons Ltd. 2007
3. Techniques and Applications of Hyperspectral Image Analysis by Hans F. Grahn and Paul Geladi, Wiley & Sons Ltd.
ESG667 Computer Vision and Advanced Image Processing (3-0-0) 3 credits

Image Formation Models, Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, 3D scanning, 3D from RGBD data, Binocular imaging systems Image Processing and Feature Extraction, point cloud processing, Triangulation and partitioning, range search, Structure from motion, Shape Representation and Segmentation, Deformable curves and surfaces, Snakes and active contours, Fourier and wavelet descriptors, Multiresolution analysis (wavelets, curvelets, countourlets, shearlets), Object recognition, Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Shape priors for recognition, simultaneous localization and mapping, digital watermarking, content based image retrieval, image compression, image matching

References:


ESG623 Microwave Remote Sensing (3-0-0) 3 credits

Passive and active microwave radiometry, radar equation, range and azimuth resolutions, concept of SAR, SAR image distortions, radar image interpretation, microwave scattering of land surface, SAR interferometry, Polarimetric SAR

Textbook


ESG668 Remote sensing and GIS for environmental and natural resource management (3-0-0-3)


References:
Remote sensing of vegetation: principles, techniques and applications. Hamlyn G. Jones and Robin A Vaughan, Oxford University Press, Oxford

ESG669 Remote sensing and GIS for atmospheric science and oceanstudies(3-0-0 -3)

State of the atmosphere; Main constituents of dry air, Vertical thermal structure of the atmosphere; Standard atmosphere; Hydrostatic equilibrium; Weather and its phenomena – Winds, cyclones, precipitation, hydrologic cycle; Surface weather and vertical structure;
Elements of radiative transfer in atmosphere- Basic quantities, Blackbody radiation – basic laws - Radiative transfer equation, Physics of Gaseous absorption, emission, Scattering, Solar radiation and surface reflection; Radiation balance;
Satellite and radar meteorology; Meteorological satellite instrumentation - Operational polar orbiting and geostationary satellites, weather sensors – passive radiometry, spectroscopy and occultation; active - Radar basics, conventional, radar and satellite rainfall measurements, , NEXRAD system, Image interpretation; Visible infrared and water vapor imagery, Spectral properties, inversion methods and Image processing techniques for atmosphere and ocean: calibration, validation and quality control for weather data products - applications of ground-based and satellite remote sensing for studies of e.g. temperature, composition, aerosol and cloud properties, precipitation, as well as the properties of sea surface and sea ice : chlorophyll, sea surface temperature, carbon sequestration.

References


ESG663 Quantitative Methods in Remote Sensing (3-0-0) 3 credits

Remote sensing data calibration, reflectance, radiance conversion, spectral reflectance and materials properties, deterministic methods, statistical, empirical methods, physically based methods, estimation of geophysical variables, forest growing stock, LST / SST, soil moisture, snow melt and runoff prediction, crop yield, rainfall, ocean chlorophyll and productivity, validation and spatial scaling.

Textbook