Appendix-

DEPARTMENT OF CIVIL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **17** **M. Tech. (Geomatics Engineering)**
Department: **CE** **Civil Engineering**
Year: **I**

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credits**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Semester- I (Autumn)														
1.	MA-501E	Optimisation Techniques	PCC	4	3	2	-	3	-	25	-	25	50	-
2.	CEN-511	Surveying Measurements and Adjustments	PCC	4	3	-	2	3	-	15	25	20	40	-
3.	CEN-512	Principles of Photogrammetry	PCC	4	3	-	2	3	-	15	25	20	40	-
4.	CEN-513	Remote Sensing and Image Processing	PCC	4	3	-	2	3	-	15	25	20	40	-
5.	CEN-514	Geodesy and GPS Surveying	PCC	4	3	-	2	3	-	15	25	20	40	-
6.	CEN-515	Field Survey Camp*	PCC	2	-	-	3	-	-	-	-	-	100	-
		Total		22	15	2	11							
** To be held in winter vacation for 10 days duration*														
Semester-II (Spring)														
1.	CEN-700	Seminar	SEM	2	0	0	2	-	-	-	-	-	100	-
2.		Programme Elective -I	PEC	4	-	-	-	-	-	-	-	-	-	-
3.		Programme Elective -II	PEC	4	-	-	-	-	-	-	-	-	-	-
4.		Programme Elective-III	PEC	4	-	-	-	-	-	-	-	-	-	-
5.		Programme Elective-IV	PEC	4	-	-	-	-	-	-	-	-	-	-
		Total		18										

DEPARTMENT OF CIVIL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

Program Code: **17** **M. Tech. (Geomatics Engineering)**
Department: **CE** **Civil Engineering**
Year: **II**

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credits**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Semester- I (Autumn)														
1.	CEN-701A	Dissertation Stage–I (to be continued next semester)	DIS	12	-	-	-	-	-	-	-	-	100	-
		Total		12										
Note: Students can take 1 or 2 audit courses as advised by the supervisor, if required.														
Semester-II (Spring)														
1.	CEN-701B	Dissertation Stage–II (contd. From III semester)	DIS	18	-	-	-	-	-	-	-	-	100	-
		Total		18										

Summary				
Semester	1	2	3	4
Semester-wise Total Credits	**22**	**18**	**12**	**18**
Total Credits	**70**			

Program Elective Courses (Geomatics Engineering)

Teaching Scheme					Contact Hours/Week			Exam Duration		Relative Weight (%)				
S. No.	Subject Code	Course Title	Subject Area	Credits	L	T	P	Theory	Practical	CWS	PRS	MTE	ETE	PRE
1.	CEN-611	Analytical and Digital Photogrammetry	PEC	4	3	-	2	3	-	15	25	20	40	-
2.	CEN-612	Advanced Digital Image Processing	PEC	4	3	-	2	3	-	15	25	20	40	-
3.	CEN-613	Thermal, Microwave and Hyperspectral Remote Sensing	PEC	4	3	-	2	3	-	15	25	20	40	-
4.	CEN-614	Theory and Applications of GIS	PEC	4	3	-	2	3	-	15	25	20	40	-
5.	CEN-615	Geoinformatics for Natural Disasters	PEC	4	3	-	2	3	-	15	25	20	40	-
6.	CEN-616	Geoinformatics for Landuse Surveys	PEC	4	3	-	2	3	-	15	25	20	40	-
7.	CEN-617	Satellite Geodesy	PEC	4	3	-	2	3	-	15	25	20	40	-
8.	CEN-618	Modelling and Analysis of Geospatial Data	PEC	4	3	-	2	3	-	15	25	20	40	-

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject Code: **CEN-511** Course Title: **Surveying Measurements and Adjustments**
2. Contact Hours : **L: 3** **T : 0** **P: 2**
3. Examination Duration (Hrs) : **Theory : 3** **Practical : 0**
4. Relative Weight : **CWS : 15** **PRS: 25** **MTE: 20** **ETE: 40** **PRE: 0**
5. Credits : **04** 6. Semester: **Autumn** 7. Subject Area : **PCC**
8. Pre-requisite: **Nil**
9. Objective of Course : To introduce the various concept of field surveying.
10. Details of Course :

Sl. No.	Contents	Contact Hours
1.	Principles of surveying, Various maps and their scales, Symbols and colours, Generalisation of information	3
2.	Surveying measuring equipments & techniques - Distance, Height, Angles and Directions. Compass Surveying: Bearings and Azimuths	4
3.	Levelling: Balancing of sights, Differential leveling, profile and cross-section leveling, reducing the levels- Height of Instrument and Rise & Fall method. Contouring	6
4.	Trigonometrical Leveling and Tacheometric surveying	5
5.	Methods of control establishment: Traversing, Traverse computations and adjustments. Triangulation and Trilateration.	7
6.	Plane Table Surveys	3
7.	Modern surveying equipments- Total Station	4
8.	Concept of observation and model, The mathematical model and errors, Random and systematic errors, Purpose of adjustments	4
9.	Least squares adjustment techniques, Adjustment by linear and non-linear functions in the model, Adjustment by observation equation (variation of parameters) and condition equation methods.	6
	Total	**42**

List of Practicals :

1. Study of different types of maps, maps in the making, conventional symbols and map numbering system.
2. Introduction to various surveying equipments – Level and Theodolites.
3. Measurement of magnetic bearing of traverse with at least five sides using Prismatic Compass.
4. Use of Auto level to determine the Reduced Level of at least five different given points (use Height of Collimation method)
5. Use of Auto level to determine the Reduced Level of a number of points by fly levelling and close the network at the given Bench Mark (use Rise and Fall method)
6. Profile and Cross-sectional levelling of a road at an interval of 20m and 2m respectively of the central line of the road using Total Station. Plot the profile and cross section on a graph sheet at a suitable scale.
7. (a) Determine the height of a building using Trigonometric Levelling.
   (b) Layout the traverse with at least five sides using Tacheometric observations.
8. Measurement of horizontal and vertical angles by Repetition and Reiteration Methods.

9. Mount drawing sheet on Plane table and draw 2cm grid on sheet. Plot the traverse on drawing sheet. Plot the details/features.
10. Plot the detail/features and draw elevation contours using Plane Table surveys.
11. Total Station for taking field measurements
12. Use of Total Station for angles and distance measurements.

11. Suggested Books :

Sl. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Arora, K.R., "Surveying", Vol. 1, 2 & 3, Standard Book House.	2005
2.	Chandra, A.M., "Higher Surveying", New Age International Publications.	2002
3.	Subramanian, R., "Surveying and Levelling", Oxford University Press.	2007
4.	Gopi, S, Sathikumar, R. and Madhu, N., "Advanced Surveying, Pearson Publications.	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject Code: **CEN-512** Course Title: **Principles of Photogrammetry**
2. Contact Hours : **L: 3 T : 0 P: 2**
3. Examination Duration (Hrs) : **Theory : 3 Practical : 0**
4. Relative Weight : **CWS: 15 PRS: 25 MTE: 20 ETE: 40 PRE: 0**
5. Credits : **04** 6. Semester: **Autumn** 7. Subject Area : **PCC**
8. Pre-requisite: **Nil**
9. Objective of Course : To introduce the various concept of photogrammetry.

1. Details of Course :

Sl. No.	Contents	Contact Hours
1.	Photogrammetry - Types of photographs, Scale determination, Flying Height, Relief and Tilt Displacements	5
2.	Stereovision, Base Lining, Parallax bar, Height determination from stereo-photographs, Flight planning.	6
3.	Porro-Koppe, Reprojection principle, Double reprojection, Equivalent and calibrated focal length of lens and concept of principal distance.	5
4.	Concepts of orientation: Interior, Relative and Absolute Orientation of Aerial Photographs.	5
5.	Optical—Mechanical, Graphical and Numerical methods of Relative orientation, Over-correction factors and its determination.	5
6.	Model deformations, Residual errors and precision of Inner and Relative Orientation, Relative Orientation in hilly terrain and in difficult country.	6
7.	Stereo-plotting Instruments: 1st, 2nd & 3rd order instruments, General principle of calibration, Testing and adjustment of instruments. Photogrammetric mapping: Basic idea of control requirement and photogrammetric extension of control.	5
8.	Fundamentals of close Range Photogrammetry, Application in Engineering and non-topographic fields.	5
	Total	**42**

List of Practicals :

1. Determination of scale and flying Height of an aerial photograph.
2. Use of Stereo Vision Test Card and Base lining of a pair of photographs.
3. Determination of height using Parallax Bar and correction contours.
4. Mapping using Sketch Master.
5. Introduction to various types of Stereo plotting machines.
6. Interior and Relative Orientation of a pair of photograph on Wild A8.
7. Absolute Orientation
8. Map plotting using Wild A8.

2. Suggested Books :

Sl. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Moffitt, F.H. and Mikhail, E.M., "Photogrammetry", 3rd Ed., Harper and Row Publisher.	1992
2.	Wolf, P.R. and Dewitt, B.A., "Elements of Photogrammetry", McGraw-Hill .	2007
3.	Luhmann, T., Robson, S., Kyle, S. and Beohm, J., "Close Range Photogrammetry and 3D Imaging", Gruyter Inc.	2013
4.	Mikhail, E.M., Bethal, J.S. and McGlove, J.C., "Introduction to Modern Photogrammetry", John Wiley and Sons.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject code: **CEN-513** Course Title: **Remote Sensing and Digital Image Processing**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs): **Theory: 03** **Practical: 0**
4. Relative Weight: **CWS: 15** **PRS: 25** **MTE: 20** **ETE: 40** **PRE: 0**
5. Credits: **04** 6. Semester: **Autumn** 7. Subject Area: **PCC**
8. Pre-requisite: **Nil**
9. Objective : To introduce the concepts of Remote Sensing and Digital Image Processing.

10. Details of Course :

Sl. No.	Contents	Contact Hours
1	Introduction: History of Remote Sensing, Remote sensing components, Sources of Energy, EMS and Radiation, Black body and associated laws Interaction of EMR with Atmosphere—Scattering, Refraction, Absorption, Transmission, Atmospheric windows, Interaction of EMR with Earth Surface—Spectral reflectance curves, Radiation Calculation,	7
2	Platforms and Sensors: Orbit al movement and Earth coverage. Sunsynchronous and Geosynchronous satellites, Active and passive sensors, PAN, Multi High resolution and Hyper spectral Sensors, Thermal and Microwave sensors, Sensors characteristics, Indian Remote Sensing Satellite Programme, Other satellites	7
3	Hard copy Images, Visual image analysis: Image interpretation: Elements, Keys and aids, Basic instrumentation, Visual interpretation of images	3
4	Image Processing software, Digital data products and their characteristics. Digital Image Formats. Colour image generation, Initial data statistics, Histogram and Scatter plot, Mosacing.	7
5	Pre-processing: Atmospheric, Radiometric and Geometric corrections.	3
6	Image enhancement, Contrast stretching, Noise removal, Low and high pass filters, other filters. Edge detection, Texture images	5
7	Ratio and NDVI Images, Taselled cap transformation, PCA and its uses	5
8	Digital image analysis: Supervised and unsupervised image classification methods, Accuracy assessment	5
	Total	**42**

List of Practicals :

1. Introduction to different types of remote sensing data products.
2. Use of spectro-radiometer to collection signature of different earth objects.
3. Training of photo interpretation files.
4. Visual Analysis of a satellite data.
5. Demo on different types of remote sensing based software.
6. Initial Statistics Extraction.
7. Atmospheric Correction.
8. Geometric Correction
9. Image Enhancement
10. Image Transformation

11. Suggested Books :

Sl. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Chandra, A.M. and Ghosh, S.K., "Remote Sensing and Geographical Information System", Narosa.	2006
2.	Gibson, P.J., "Introductory Remote Sensing – Principles and Concepts", Routledge.	2000
3.	Gibson, P.J. and Power, C.H., "Introductory Remote Sensing – Digital Image Processing and applications", Routledge.	2000
4.	Gonzales, R.C. and Woods, R.E., "Digital Image Processing", 2nd Ed., Pearson Education.	2006
5.	Jain, A.K., "Fundamentals of Digital Image Processing", Prentice Hall.	2004
6.	Lillesand, T.M. and R.W. Kiefer, "Remote Sensing and Image Interpretation", 4th Ed., John Wiley.	2000
7.	Mather, P.M., "Computer Processing of Remotely Sensed Images", John Wiley.	1999
8.	Schowengerdt, R.A., "Remote Sensing – Models and Methods for Image Processing", Academic Press.	1997

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject Code: **CEN-514** Course Title: **Geodesy and GPS Surveying**
2. Contact Hours : **L: 3 T : 0 P: 2**
3. Examination Duration (Hrs) : **Theory : 3 Practical: 0**
4. Relative Weight : **CWS: 15 PRS: 25 MTE: 20 ETE: 40 PRE: 0**
5. Credits : **04** 6. Semester: **Autumn** 7. Subject Area : **PCC**
8. Pre-requisite: **Nil**
9. Objective of Course : To understand the basics of geodesy and global positioning system which will help to further broaden one's background in the general field of geomatics engineering.

10. Details of the Course

S. N.	Contents	Contact Hours
1	Introduction to geodesy & its development	2
2	Earth and its size & shape, Earth and its motions- annual, spin, precession, nutation, polar motion	8
3	Earth and its gravity field – anomaly, gravity potential, geoid & deflection to vertical	5
4	Earth and its atmosphere – physical properties, wave propagation through atmosphere, temporal variations, gravitational field of the atmosphere.	5
5	Introduction to GPS- its components, Instruments & processing software, GPS signals. GPS data collection, Planning & Methods	7
6	GPS observables- Pseudo range and carrier phase; Parameter Estimations	6
7	Data Handling- Cycle slip detection and correction, Ambiguity resolution, GPS data processing, Errors in GPS data – Satellite Geometry, Multipath errors & corrections; Accuracy of GPS data	7
8	Datum transformation	2
	Total	**42**

List of Practicals :

1. Demonstration, hands-on practice and temporary adjustments of a Gravimeter.
2. Demonstration, hands-on practice and collection of data using navigational GPS receiver. Further, download and process the data using software.
3. Demonstration, hands-on practice and collection of data using Geodetic GPS receivers. Further, download and process the data using software.
4. To determine the relative as well as absolute gravity of some stations and along a profile of 100meter at an interval of 5 meter. Find the location of the stations as well as plot the profile using GPS receivers.
5. To determine the height of a tower using a Gravimeter and verify the result with that by using GPS receiver.
6. To determine the variations of gravity with elevation. Determine the elevation of the stations using GPS receiver.
7. To determine the gravity anomaly profile in the IITR campus having absolute locations of the stations using GPS receivers.

11. Suggested Books :

Sl. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Bomford, G., “Geodesy”, Clarendon Press, Oxford.	1980
2.	Hoffmann-Wellenhoff, B., “GPS Theory & Practice”, Springer.	2001
3.	Leick, A., “GPS Satellite Surveying”, John Wiley.	2005
4.	Torge, W., “Geodesy : An Introduction”, Walter de Gruyter, Berlin.	1980
5.	Vanicek, Peter and Krakiwsky, E.J., “Geodesy : The Concepts”, Elsevier.	1986

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject Code: **CEN-611** Course Title: **Analytical and Digital Photogrammetry**
2. Contact Hours : **L: 3 T : 0 P: 2**
3. Examination Duration (Hrs) :**Theory : 3 Practical : 0**
4. Relative Weight : **CWS: 15 PRS: 25 MTE: 20 ETE: 40 PRE: 0**
5. Credits : **4** 6. Semester: **Spring** 8. Subject Area : **PEC**
8. Pre-requisite: **Principles of Photogrammetry**
9. Objective of Course : To provide enhanced knowledge on analytical and Digital Photogrammetry.

10. Details of Course :

Sl. No.	Contents	Contact Hours
1	Introduction, Historical development from conventional to analytical and digital photogrammetry, Applications of analytical and digital photogrammetry	4
2	Coordinate systems, Condition equations, Orthogonal transformation matrices and methods of construction, Approximate orthogonal matrix, Measurement of image coordinates from hard copy and soft copy; Instruments	5
3	Digital images and their properties, Direct and indirect methods of acquisition of digital images - CCD, Digitizers and photogrammetric scanners, Comparative merits, Storage and compression of digital imagery, Loss of data & image quality, Corrections to observed image coordinates	5
4	Analytical orientation, Relative, Absolute and Exterior orientation methods, Analytical plotter and its functioning, Automatic image matching techniques - signal based and feature based matching, Comparative merits and demerits,	5
5	Digital correlation, Least square matching, Multipoint matching etc., Model formation using digital stereo pairs, Automatic generation of DEM, Digital orthophotos,	7
6	Digital photogrammetric system - Potential, Capabilities and characteristics features, Design consideration, Add-on devices	6
7	Analytical aerial triangulation, Independent model triangulation, Strip and block triangulation and adjustment, Bundle block adjustment. Various applications	10
	Total	**42**

List of Practicals :
1. Introduction to Digital Photogrammetric System.
2. Preparation of Digital Photo
3. Interior Orientation.
4. Relative Orientation.
5. Relative Orientation.
6. Absolute Orientation
7. 3D Model generation
8. Generation of Digital orthophotograph.
9. Aero triangulation

11. Suggested Books

Sl. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Ghosh, Sanjib K., "Analytical Photogrammetry", Concept Publishing Co.	1987
2.	"Manual of Photogrammetry", American Society of Photogrammetry.	1995
3.	Linder, Wilfried, "Digital Phgotogrammetry", Springer.	2009
4.	Egals, Yves and Kasser, Michel, "Digital Photogrammetry", Taylor and Francis.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject Code: **CEN-612** Course Title: **Advanced Digital Image Processing**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs): **Theory: 03 Practical: 0**
4. Relative Weight: **CWS: 15 PRS: 25 MTE: 20 ETE: 40 PRE: 0**
5. Credits: **4** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Pre-requisite: **Remote Sensing and Digital Image Processing**
9. Objective : To introduce the concepts of multi and hyper-spectral remote sensing.
10. Details of Course :

Sl. No.	Contents	Contact Hours
1	Various types of images: PAN, Mutispectral, Hyperspectral and High resolution images, Feature and intensity based image registration of images, Open Source Image Processing software and image data	4
2	Advanced Spatial Filtering techniques—Spatial and Frequency domain (e.g., Fourier, wavelets), Texture Images	6
3	Image compression, Pixel and sub-pixel level target detection and classification, Data fusion methods and applications.	5
4	DEM generation from stereo-satellite images, CARTOSAT DEM, SRTM DEM, ASTER DEM, Parameter extraction	5
4	Empirical modelling of biophysical parameters from multi and hyperspectral remote sensing data, 3D visualisation of data	8
5	ANN, Fuzzy Logic, Object based classification from satellite images	8
6	Applications of multi and hyperspectral remote sensing data in water resources, forestry, earth sciences, resource management and planning, military target detection.	6
	Total	**42**

List of Practicals :
1. Study of different types of remote sensing data
2. Hands on experience on images processing modules
3. Data visualization tools – study of images
4. Feature and intensity based image registration of images
5. Spatial enhancement of remote sensing images
6. Data dimensionality reduction using feature selection and feature extraction methods
7. Advanced pattern recognition algorithms for extraction of information from images
8. Derivation of biophysical parameters from multi and hyperspectral remote sensing images

11. Suggested Books :

Sl. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Chen, C.H., “Information Processing for Remote Sensing”, World Scientific.	1999
2.	Cheng, Chein I., “Hyperspectral Imaging : Techniques for Spectral Detection and Classification”, Kluwer Academic.	2003

3.	Landgrebe, D., “Signal Theory Methods in Multi-spectral Remote Sensing”, John Wiley.	2003
4.	Richards, John A. and Xiuping, Jia., “Remote Sensing Digital Image Analysis : An Introduction”, Springer-Verlag.	1999
5.	Varshney, P.K. and Arora, Manoj K., “Advanced Image Processing Techniques for Hyperspectral Remote Sensing Data”, Springer-Verlag.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject Code: **CEN-613** Course Title: **Thermal, Microwave and Hyperspectral Remote Sensing**
2. Contact Hours : **L: 3 T : 0 P: 2**
3. Examination Duration (Hrs) : **Theory : 3 Practical : 0**
4. Relative Weight : **CWS : 15 PRS : 25 MTE : 20 ETE : 40 PRE : 0**
5. Credits : **4** 6. Semester: **Spring** 7. Subject Area : **PEC**
8. Pre-requisite: **Nil**
9. Objective of Course : To provide enhanced knowledge on the use of thermal, microwave and hyperspectral remote sensing data and their analysis for various engineering and other applications.

9. Details of Course :

Sl. No.	Contents	Contact Hours
1.	Brief review of thermal and microwave remote sensing, their utility, merit and demerits. Introduction to spectral characteristics of remote sensing data. Optical radiation models. Summary of Visible to Shortwave region models. Thermal sensors and their characteristics.	4
2.	Thermal infrared region models. Interpretation of thermal images – day and night images. Emmissivity consideration. Thermal inertia considerations. Factors affecting analysis of thermal images..	5
3.	Estimation of land surface temperature from thermal images. Applications of thermal remote sensing.	3
4.	Introduction to Microwave Remote Sensing - Active and Passive Systems, Platforms and Sensors.	5
5.	Passive Microwave Systems: Background, Mathematical formulation for microwave radiation and simulation, Measurement and analysis of Brightness Temperature, Applications in various fields— Oceanography and Meteorology.	4
6.	Active Microwave Systems: Basic principles of Radar, Radar Equation, Resolution, Range, Phase and Angular measurements, Microwave Scattering and its measurement, Relationships between Scene and Sensor parameters, Imaging systems – RAR and SAR. SAR Imagery—their characteristics and interpretation. Applications of microwave remote sensing.	6
7.	SAR Interferometry for DEM generation. Differential SAR Interferometry for surface displacement studies. Applications in land subsidence, landslide movements, glacier movements etc. Polarimetry in Radar Remote Sensing. Basic equations. Propagation of waves and wave polarization. HH, VV, HV and VH polarization data and their applications.	4
8.	Principles of Hyperspectral Remote Sensing, Spectral Cube, Airborne and spaceborne hyperspectral sensors	4
9.	Smile effect and correct, instrument calibration: geometric and spectral calibration, continuum removal, red edge and blue shift concepts	3
10.	Spectral mixing theory, waveform characterization, spectral mapping methods: spectral feature filtering (SFF), Linear Spectral Unmixing (LSU), Mixture Tuned Matched Filtering (MTMF). Spectral Angle Mapper (SAM)	4
	Total	**42**

List of Practicals :

1. Familiarisation with various thermal and microwave remote sensing data products
2. Hands on experience on thermal data and microwave data processing modules in an image processing software
3. Study and collection of emmissivity data pertaining to various earth surface features from different sources.
4. Visual image interpretation of thermal images.
5. Digital image interpretation of thermal images.
6. Land surface temperature estimation from thermal images
7. Study and implementation of brightness temperature estimation models for passive microwave remote sensing data
8. Study and implementation of backscatter estimation models for active microwave remote sensing data
9. Visual and Digital image interpretation of SAR images.
10. Use of Differential SAR Interferometry for surface displacement studies.
11. Collection of spectral signatures and study of hyperspectral image
12. Classification of hyperspectral data

11. Suggested Books :

Sl. No.	**Name of Authors/Books/Publishers**	**Year of Publication/ Reprint**
1.	Henderson, F.M. and Anthony, J.L., "Principles and Applications of Imaging Radar", Manual of Remote Sensing, Vol. 2. John Wiley.	1998
2.	Manual of Remote Sensing, Vol. 1 to 5, American Society of Photogrammetry and Remote Sensing.	2003
3.	Schowengerdt, R.A., "Remote Sensing Models and Methods in Image Processing", Academic Press.	2006
4.	Matzler, C., "Thermal Microwave Radiation: Application for Remote Sensing", Institute of Electrical Engineers (IEE).	2008
5.	Chang, Chein, I., "Hyperspectral Data Processing", John Wiley and Sons.	2013

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject Code: **CEN-614** Course Title: **Theory and Applications of GIS**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs): **Theory : 3 Practical : 0**
4. Relative Weight : **CWS : 15 PRS : 25 MTE : 20 ETE : 40 PRE : 0**
5. Credits: **4** 6. Semester : **Spring** 7. Subject Area: **Civil Engineering**
8. Pre-requisite : **Nil**
9. Objective of Course: The course objective is to provide basic knowledge of GIS theory and engineering applications using the existing state-of-the-art GIS software. The course shall be taught using a combination of lectures, demonstrations, and hands-on, interactive practicals in the classroom.

10. Details of Course:

Sl. No.	Contents	Contact Hours
1	Introduction, Geographical concepts and Terminology, Difference between Image Processing system and GIS, Utility of GIS.	4
2	Various GIS packages and their salient features, Essentials components of GIS, Data acquisition through scanners and digitizers	5
3	Raster and Vector Data: Introduction, Descriptions: Raster and Vector data, Raster Versus Vector, Raster to Vector conversion, Remote Sensing Data in GIS, Topology and Spatial Relationships, Data storage verification and editing	7
4	Data preprocessing, Georeferencing, Data compression and reduction techniques, Runlength encoding, Interpolation of data, Database Construction, GIS and the GPS, Data Output	7
5	Database structure, Hierarchical data, Network systems, Relational database, Database management, Data manipulation and analysis	4
6	Spatial and mathematical operations in GIS, Overlay, Query based, Measurement and statistical modelling, Buffers, Spatial Analysis, Statistical Reporting and Graphing	5
7	Programming languauges in GIS, Virtual GIS, Web GIS	5
8	Application of GIS to various natural resources mapping and monitoring and engineering problems	5
	Total	**42**

List of Practicals :

1. Demo on various GIS software and their salient features.
2. Scanning and digitization (on screen).
3. Registration of various maps and digitization and editing of features.
4. Database creation and management.
5. Buffer and overlay analysis.
6. Map preparation and composition.
7. Spatial and Mathematical operations.
8. Area and query based analysis
9. Customized application in GIS.
10. Web publishing of GIS layers.

11. 3D GIS.
12. Demo on various GIS based application.

11. Suggested Books

Sl. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1	Burrough, P.A. and Mc Donnel, R.A., "Principles of Geographic Information System", Oxford University Press.	2000
2	Chrisman, Nicholas R., "Exploring Geographic Information Systems", John Wiley.	2002
3	Demers, Michael N., "Fundamentals of Geographic Information System", 2nd Ed. Wiley.	2008
4	Ghosh, S.K. and Chandra, A.M., "Remote Sensing and GIS", Narosa Publishing House.	2008
5	Lo, C.P. and Young, A.K.W., "Concepts and Techniques of Geographical Information System", Prentice Hall India.	2002
6	Longley, Paul A, Goodchild, Michael F., Maguire, David J. and Rhind, David W., "Geographic Information Systems and Science", Wiley	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject code: **CEN-615** Course Title: **Geoinformatics for Natural Disasters**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs): Theory: **3** Practical: **0**
4. Relative Weight: CWS: **15** PRS: **25** MTE: **20** ETE: **40** PRE: **0**
5. Credits: **4** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Pre-requisite: **Nil**
9. Objective : To introduce the applications of remote sensing, GIS and GPS tools for disaster mitigation and management.

10. Details of Course :

Sl. No.	Contents	Contact Hours
1	Introduction to various types of disasters. Manmade and natural – earthquakes, volcanoes, landslides, floods, cyclones, tsunamis, anthropogenic, industrial, chemical and environmental, fire etc. Stages of a disaster mitigation plan- pre-disaster planning, disaster preparedness, monitoring phase, emergency response or damage assessment, recovery and relief phase.	4
2	Various Geomatics tools – Total Station, GPS, RS, GIS, Digital Elevation model Generation extraction of parameters and their uses.	2
3	Earthquakes – Causative factors, hazard assessment, selection of factors, SAR Interferometry for estimation of ground displacement, creation of thematic data layers, preparation of seismic hazard zonation maps, regional risk assessment, Geomatics tools for risk mitigation plans. Case studies. Damage Assessment.	5
4	Landslides – Causative factors, hazard assessment, selection of factors – triggering and non-triggering, creation of thematic data layers, preparation of landslide hazard zonation maps, regional and site specific risk assessments, Modeling for risk mitigation plans. Case studies	6
5	Cyclones and Flooding: Cyclone: cyclone related parameters and effects on land and sea – damage assessment. Flooding: causes, identification of factors, space-time integration, GIS data layers, flood prone area demarcation, analysis and management, risk assessment. Damage Assessment. Case studies, Damage assessment.	5
6	Drought and Desertification: Types of droughts, factors influencing droughts, identification of variables, development of vegetation index, assessment of land use and ground water level changes, delimiting drought prone areas, processes of desertification, over utilization of water and land resources. GIS data layer creation – Management strategies. Case studies.	4
7	Anthropogenic Disasters: Atmospheric Disasters : Ozone layer depletion, green house / global warming – acid rain – snow melt – sea level rise – related problems. GIS data layer creation. Case studies. Marine Disasters: oil spill and chemical pollution, coastal erosion and deposition, factor identification, GIS analysis, management strategies. Case studies.	5
8	Biodiversity Disasters: Ecological degradation – nuclear disaster and biodiversity loss. Identification of parameters (mapping of forest types, protected areas and natural forests) – population extinction – conserving bio-diversity (species and subspecies). Soil erosion, coral / mangrove depletion, forest fire-mining. Geomatics tools for preparation	5

	of ecological degradation maps, erosion maps, deforestation maps etc. GIS in environmental modeling. Case studies.	
9	Forest Fire: estimation of forest fire, extent – NBR (Normal Burnt Ratio), use of geomatics tools for monitoring and management, Damage assessment.	3
10.	Tsunami - Introductory concepts, Geomatics tools and systems for monitoring and management, damage assessment.	3
	Total	**42**

List of Practicals :

1. Familiarisation with various remote sensing data products at different spectral, spatial and temporal resolutions
2. Hands on experience on Total Station
3. Hands on experience on GPS.
4. Hands on experience on an image processing and GIS software.
5. Digitization of Thematic layers.
6. Collection of data from different sources for a given natural hazard
7. Collection of field data using Total Station and/or GPS survey for the natural hazard selected
8. Use of GIS for preparation of thematic data layers for the natural hazard selected
9. Use of GIS for hazard zonation using probabilistic or any other method
10. Use of GIS for risk zonation and assessment.
11. Flood plan mapping using temporal satellite data (pre and post flood).
12. Use of Differential SAR Interferometry for surface displacement studies.

11. Suggested Books :

Sl. No.	**Name of Authors/Books/Publishers**	**Year of Publication/ Reprint**
1.	Andrew, Skeil, "Environmental Modeling with GIS and Remote Sensing", John Willey.	2002
2.	Ariyabandu, M. and Sahni P. (Eds), "Disaster Risk Reduction in South Asia", Prentice-Hall.	2003
3.	Bossler, J.D., "Manual of Geospatial Science and Technology", Taylor and Francis, London.	2001
4.	Demers, Michael N., "Fundamentals of Geographic Information Systems", John Willey.	2000
5.	Matthews, John A., "Natural Hazards and Environmental Change", Bill McGuire, Ian Mason.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject Code: **CEN-616** Course Title: **Geoinformatics for Land Use Surveys**
2. Contact Hours: **L: 3** **T: 0** **P: 2**
3. Examination Duration (Hrs): **Theory: 3** **Practical: 0**
4. Relative Weight: **CWS: 15** **PRS: 25** **MTE: 20** **ETE: 40** **PRE: 0**
5. Credits: **4** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Pre-requisite: **Nil**
9. Objective of Course : To impart advanced knowledge on the use of remote sensing data in optical region for preparation of land use land cover maps and their usage in urban planning

10. Details of Course :

Sl. No.	Contents	Contact Hours
1	Introduction. Land use land cover— definition and its significance in engineering projects. History of land use land cover. Modern land use land cover surveys and classification systems. Utility of remote sensing data for land use land cover mapping at various scales.	4
2	Land use land cover analysis based on spectral characteristics of remote sensing data - Visible, Near Infrared and Shortwave Infrared wavelength regions, Thermal Infrared regions and active microwave region, high resolution images, various vegetation indices.	8
3	Land use land cover analysis based on spatial characteristics of remote sensing data – utility of IFOV, land parcel sizes, minimum mapping unit, map scale, Land use land cover analysis based on temporal characteristics of remote sensing data – temporal resolution of remote sensing data, application based temporal requirements, land use land cover change detection – visual and digital change detection algorithms. Principles of land use land cover mapping. Visual image interpretation techniques for land use cover map preparation.	8
4	Digital image classification for land use land cover map preparation. Per pixel classification – statistical, artificial neural network and other machine learning approaches. Object based image classification. Concept of mixed pixel. Sub pixel classification – linear mixture modeling, fuzzy set based classification, artificial neural network and other machine learning approaches.	9
5	Classification accuracy assessment – accuracy of per pixel and sub-pixel classification. Sampling design issues, design of error matrix and fuzzy error matrix. Statistical testing.	4
6	Issues in urban and regional planning – objectives and planning processes, data requirements. Physical planning and statistical methods. Mapping of parcels and individual buildings, Utility of land use land cover in urban planning.	4
7	Role of remote sensing and GIS for urban planning, management, and growth assessment. Study of cropping pattern and resources. Utility/service planning. Transportation planning and management. Infrastructure planning.	5
	Total	**42**

List of Practicals :

1. Familiarization with various photographic and digital remote sensing data products used for land use land cover mapping.
2. Study of spectral reflectance characteristics of various land use land cover features using Spectro-Radiometer.
3. Preparation of land use land cover classification scheme for an area.
4. Study of image interpretation elements through image interpretation keys for visual analysis of land use land cover. Preparation of a land cover map from the given FCC. Take minimum mapping unit as 5 mm x 5 mm. Compute areas of various land cover classes mapped using digital planimeter.
5. Training on image classification module of ERDAS Imagine. Practice for selection of training areas and their quality assessment using histogram and separability analyses.
6. Comparative assessment of various statistical image classifiers for land use land cover mapping. Practice for selection of testing areas based on different sampling schemes for classification accuracy assessment in ERDAS Imagine.
7. Preparation of a land use land cover map using back propagation neural network algorithm (use either Matlab, IDRISI or ENVI software).
8. Preparation of land use land cover map at sub-pixel level using soft classification techniques (use either ERDAS, IDRISI or ENVI software).
9. Preparation of land parcel and building map from high resolution satellite image.
10. Development of a computer program to implement an advanced image classification algorithm (e.g., decision tree classifier, evidential reasoning or any other).
11. Preparation of a land use land cover change detection map using various image change detection algorithms (use either ERDAS, IDRISI or ENVI software).

11. Suggested Books :

Sl. No.	**Name of Authors/Books/Publishers**	**Year of Publication/ Reprint**
1.	Campbell, J. B., "Introduction to Remote Sensing", Guilford Press.	2002
2.	Lillesand, T.M. and R.W. Kiefer, "Remote Sensing and Image Interpretation", 4th Ed., John Wiley.	2000
3.	Mather, Paul M., "Computer Processing of Remotely-Sensed Images", John Wiley.	1999
4.	Rencz, Andrew B. (Editor-in-Chief), "Remote Sensing for Natural Resource Management and Environmental Modeling", Manual of Remote Sensing, Vol. 4. John Wiley.	2004
5.	Rencz, Andrew B. (Editor-in-Chief), "Remote Sensing of Human Settlements", Manual of Remote Sensing, Vol. 5, John Wiley.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject Code: **CEN- 617** Course Title: **Satellite Geodesy**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs): **Theory: 3 Practical: 0**
4. Relative Weight: **CWS: 15 PRS: 25 MTE: 20 ETE: 40 PRE: 0**
5. Credits: **4** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Pre-requisite: **Nil**
9. Objective of Course : To provide enhanced knowledge on satellite geodesy and its applications in GPS.

10. Details of Course :

Sl. No.	Contents	Contact Hours
1	Introduction, Fundamentals: Reference coordinate systems, Time, Signal Propagation.	7
2	Satellite Orbital Motion: Fundamental of Celestial Mechanics, Purturbed Satellite Motion, Orbit determination, Satellite Orbit & Orbital Maneuvers	8
3	Basic Observation Concepts and Geodetic Satellites: Satellite Geodesy for parameter estimation, Observables and basic concepts, Satellites used in geodesy, GNSS systems-GPS, GLONASS, Galelio etc	9
4	Satellite Altimetry – basics, satellites & missions, Measurements, corrections, Data Processing and Accuracy, determination of mean sea surface.	5
5	Laser Ranging- Systems and components; Measurements, corrections, Data Processing and Accuracy; Applications	5
6	Planned Missions and Special Methods – VLBI.	3
7	Applications of Geodetic Satellite Methods – Positioning, Gravity Field and Earth Models, Navigation, Geodynamics.	5
	Total	**42**

List of Practicals :

1. Demonstration, hands-on practice and collection of data using Geodetic GPS receivers. Further, download and process the data using commercial software.
2. Demonstration, hands-on practice and analysis of 7 days GPS data using BERNESE software.
3. Demonstration, hands-on practice and analysis of 7 days GPS data using GAMIT software.
4. To determine the different orbit and satellite parameters from GPS data.
5. Process and analyse laser ranging data.
6. Process and analyse VLBI data.

11. Suggested Books :

Sl. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Kaula, W.A., “Theory of Satellite Geodesy”, Dover Pub. Inc. NY	2000
2.	Seeber, Gunter, “Satellite Geodesy: Foundations”, Methods and Applications. Walter De Gruyter, NY.	2006
3.	Mueller, I.I., “Introduction to Satellite Geodesy”, Ungar Pub.	1964
4.	Tishchenko, A.P., “Geometrical Methods of Space Geodesy”, NASA Pub.	1971

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Civil Engineering**

1. Subject Code: **CEN-618** Course Title: **Modeling and Analysis of Geo-Spatial Data**
2. Contact Hours: **L: 3 T: 0 P: 2**
3. Examination Duration (Hrs): **Theory: 3 Practical: 0**
4. Relative Weight: **CWS: 15 PRS: 25 MTE: 20 ETE: 40 PRE: 0**
5. Credits: **4** 6. Semester: **Spring** 7. Subject Area: **PEC**
8. Pre-requisite: **Nil**

9. Objective of Course : To introduce various modeling and error analysis techniques for processing of geo-data acquired from surveying, photogrammetry, GPS, remote sensing and GIS.

10. Details of Course :

Sl. No.	Contents	Contact Hours
1.	**Types of Geo-spatial Data**: Ratio, Categorical and Ordinal Data. Spatial and Non-spatial data. Vector and Raster Data. Primary and Secondary Data.	5
2.	**Multi Criterion Decision Making:** Standardisation of weights, Analytical Hierarchical Process (AHP), Spatial Decision Support System	4
3.	**Coordinate Transformations:** Two-Dimensional, Conformal, Affine, Projective Coordinate Transformation. Three-Dimensional Conformal Coordinate Transformation. Map models and Map Projection Systems	5
4.	**Geo-spatial Data Structures and Database Management Systems**: Data Compression Models, DBMS and Relational DBMS. File Formats for various GIS Data Types. Digital Remote Sensing Data: File Formats.	6
5.	**Measurements and Analysis**: Sample versus Population. Graphical Representation of Geo-spatial Data. Measures of Central Tendency – Mean, Median, Mode. Mean Vector. Measures of Variation in Data - Variance Covariance and Correlation Matrices.	5
6.	**Error in Geo-spatial Data and Error Modeling**: Error Sources, Types of Errors – Gross, Systematic and Random Errors. Precision, Accuracy and Uncertainty. Errors in Geospatial data and measurements, Propagation of Random Errors.	4
7.	**Principles of Least Squares**. Observation Equations. Systematic Formulation of the Normal Equations. Using Matrices to Form the Normal Equations. Least Squares Solution of Nonlinear Systems. Least Squares Fit of Points to a Line or Curve. Concept of Adjustment of Errors. Least Squares Adjustment Using Conditional Equations and Observation Equations	5
8.	**Confidence Intervals and Statistical Testing**: Sampling Distributions. Sampling Schemes and Sample Sizes. Confidence Interval for the Mean: *t* Statistic. Confidence Interval for a Population Variance. Confidence Interval for the Ratio of Two Population Variances. Hypothesis Testing. Uses of Statistical Testing in Geo-spatial Data Processing.	5
9.	**Uncertainty Modeling of Geo-spatial Data**: Uncertainties in various Geo-spatial Data, Fuzzy set, Monte Carlo Simulations. Error Ellipse for Uncertainty Quantification.	3
	Total	**42**