Geoinformatics for Natural Resources Management

1.1. Brief about the Program

- **Program Host** : Hashemite University
- **Study Plan** : M.Sc. Degree
- **Plan Type** : Thesis
- **Academic Year** : 2019
- **Number of Credit Hours** : 33 Credit Hours

1.2. Motiovation of the Program

A strategic vision to ensure a sustainable use of natural resources is a challenge, particularly for such a small country as Jordan, faced with a critical imbalance and a high risk of environmental problems.

In order to provide sustainable and equitable long-term natural resources management plans for the future, the Hashemite University will establish a Master program that aims at support the country goals to achieve its Sustainable Development Goals (SDGs). The program will focus on utilizing state-of-art Geoinformatics technologies including; GIS, GNSS, Remote Sensing, Hyperspectral Sensors, Spatial Database, Web and Mobile Applications and other to aid in sustainable management of natural resources in Jordan

1.3. Competences and learning outcomes

- Ability to acquire, process, and analyze hyperspectral and 3D remotely sensed data.
- Ability to write computer programs for natural resources spatial problems.
- Ability to design, implement, and interpret geo-statistical analyses.
- Ability to plan and apply experimental design, and analyze, integrate, and manage spatial data bases
- Ability to design web based GIS applications and build mobile GIS applications
- Ability to acquire, process, and integrate GNSS data in GIS environment
- Ability to use GIS software and perform spatial analyses
- Ability to design and manage GIS projects
- Ability to assess, evaluate, monitor, manage, and interpret natural hazards, land, water, and geological sustainability related issues using geo-informatics
- Ability to choose, develop, customize GIS/RS solutions to real life problems
- Skills to communicate effectively with both specialists and non-specialists audiences
- Ability to engage in life-long learning
- Understanding of professional and ethical responsibilities
- Ability to analyze a multi-dimensional data set for natural resources management

1.4. Employment/career opportunities

Graduates from this program will have great chance to find job opportunities in the following governmental agencies and private sectors:

- Ministry of Energy and Mineral Resources
- National Petroleum Company
- The Ministry of Environment
- The Ministry of Public Works and Housing
- Ministry of Municipal and Rural Affairs
- Ministry of Agriculture
- Royal Jordanian Geographical Center
- Royal Scientific Society
- The Ministry of Planning and International Cooperation
- Jordanian Armed Forces
- Ministry of Water and Irrigation
- Ministry of Transport and Communications Sector
- Department of Statistics
- Phosphate Company
- Universities and scientific institutes
- The Ministry of Tourism and Antiquities
- Ministry of Tourism
- National Electricity Company
- Private sector (engineering and mining companies, space companies, consulting firms, etc)

1.5. Curriculum

a) **Compulsory courses**: (15) Fifteen credit hours as follow:

Course Name	Weekly Hours		Credit Hours	Prerequisites
	Theoretical	Practical		
Computer Programming in Geospatial Processes	2	1	3	-
Data Mining	2	1	3	-
Research methodology & communication skills	1	0	1	-
Hyper-spectral and 3D Remote Sensing	2	1	3	-
Geospatial Database	2	1	3	-
GIS and GNSS Projects	2	1	3	-

b) **Elective courses**: (9) Nine credit hours selected from the following list:

Course Name	Weekly Hours		Credit Hours	Prerequisites
	Theoretical	Practical		
Geospatial Data Analysis	1	1	2	Data Mining
Risk Assessment of Natural Hazards	2	1	3	Geospatial data analysis and GIS and GNSS Projects
GIS applications for Land Management	2	1	3	
Water Resources Management Using Geomatics	2	1	3	
Geological Applications Using Geomatics	2	1	3	
GIS Web and Mobile Applications	3	0	3	

c) **Thesis:** (9) Nine credit hours.

1.6. Competence matrix

			Computer Programming in	Data Mining	Research and Professional	Hyper-Spectral and 3D Remote	Geospatial Database	GIS and GNSS Projects	Geospatial data analysis	Risk Assessment of Natural Hazards	GIS applications for Land	Water Resources Management	Geological Applications using	GIS Web and Mobile
Broad Knowledge	1	Ability to acquire, process, and analyze hyperspectral and 3D remotely sensed data.				X		X						
	2	Ability to write computer programs for natural resources spatial problems.	X				X							X
	3	Ability to design, implement, and interpret geostatistical analyses.		X			X		X					
Speicific Knowledge	4	Ability to plan and apply experimental design, and analyze, integrate, and manage spatial data bases		X			X	X	X	X	X	X	X	X
	5	Ability to design web based GIS applications and build mobile GIS applications					X							X
	6	Ability to acquire, process, and integrate GNSS data in GIS environment						X						
Practical Skills	7	Ability to use GIS software and perform spatial analyses						X	X	X	X	X	X	X
	8	Ability to design and manage GIS projects						X		X	X	X	X	X
	9	Ability to assess, evaluate, monitor, manage, and interpret natural hazards, land, water, and geological sustainability related issues using geo-informatics								X	X	X	X	
	10	Ability to choose, develop, customize GIS/RS solutions to real life problems						X		X	X	X	X	X
Soft Skills	11	Skills to communicate effectively with both specialists and			X			X		X	X	X	X	X
	12	Ability to engage in life-long learning			X	X		X		X	X	X	X	X
	13	Understanding of professional and ethical responsibilities	X	X	X	X	X	X	X	X	X	X	X	X
	14	Ability to analyze a multi-dimensional data set for natural resources management		X			X		X	X	X	X	X	X

1.7. Syllabus for all courses related to geodesy

Course Name	Computer Programming in Geospatial Processes
Credit Hours	3 CH (11 ECTS credits): 2 CH theoretical + 1 CH Practical
Course Description	Understanding programming concepts, objected-oriented programming, data types, inputs and outputs, control structures and function, programming skills using R or Python, and graphical user interface (GUI). Practical part includes programming using Python or R.
Learning Outcomes	After completing the course, the students will be able to: • Write, test and debug object-oriented programs for geospatial data. • Describe and implement object-oriented paradigm concepts in software system implementation, reusing code by applying aggregation and inheritance. • Handle exceptions in programming • Access relational databases • Develop a graphical user interface.
Syllabus (List Of Lessons)	• General Description about programming • Introduction to Python/R programming language. • Data types • Input-output • Control structures and functions • Programming in Python/R • Python/R -studio interfaces • Manipulation of data • Graphical user interface • Scripts and functions • Object-oriented paradigm, Object-oriented programming concepts. • Handling Exceptions • Graphical User Interface (GUI) development
Prerequisite	None
Course Literature	• Prabhanjan Tattar, Tony Ojeda , Sean Patrick Murphy , Benjamin Bengfort, Abhijit Dasgupta (2017), **Practical Data Science Cookbook: Data pre-processing, analysis and visualization using R and Python**, Prabhanjan Tattar, Tony Ojeda , Sean Patrick Murphy , Benjamin Bengfort, Abhijit Dasgupta, Second Edition, PacktPub,UK. • Charles R Severance (2013), **Python for Informatics: Exploring Information,** Charles Severance, USA. • Garrett Grolemund , Hadley Wickham (2015), **Hands-On Programming with R**, Second Edition, Garrett Grolemund, USA.

Course Name	Data Mining
Credit Hours	3 CH (11 ECTS credits): 2 CH theoretical + 1 CH Practical
Course Description	Handling, distinguishing, and implementation of sampling techniques, descriptive analyses concepts and methodologies, simple and advanced statistical modelling techniques. Practical part includes data quality control, mining, model selection, and interpretation for natural resources problem.
Learning Outcomes	After completing the course, the students will be able to: • Formulate and apply an experimental design • Distinguish and differentiate between modelling techniques • Compare and decide on best model based on accuracy assessment • Interpret the results of statistical analyses for natural resources management • Use mainstream software tools to solve statistical problem • Write a report and do a presentation with the results of performing spatial analyses.
Syllabus (List Of Lessons)	• Sampling techniques • Descriptive analyses • Data Quality Assessment • Parametric and Nonparametric comparisons • Simple modelling (LR, Logistic, MLR, SWR) • Advanced modelling techniques (non-linear, clustering, partitioning, PLS, Fuzzy, ANN) • Accuracy assessment and Model Selection
Prerequisite	None
Course Literature	• Jiawei Han, Micheline Kamber, Jian Pei (2012), **Data Mining: Concepts and Techniques**, Elsevier, USA. • Charu C. Aggarwal (2015), **Data Mining: The Textbook**, Springer International Publishing, Switzerland. • Robert Layton (2017), **Learning Data Mining with Python**, Second Edition, PacktPub,UK. • Andrea Cirillo (2017), **R Data Mining**, PacktPub,UK.

Course Name	Research and Professional Development
Credit Hours	1 CH (3.6 ECTS credits)
Course Description	Professionalizing Research in terms of aims, types, Categories, quality, Bibliometric services, Research process, Research article, Communicating and Ethics. Practice professional networking, company meetings, response to proposals for services, and interviews. Particular emphasis on verbal communication, creating career plans and prepare a developmental roadmap.
Learning Outcomes	After completing the course, students will be able to: • Formulate a thesis proposal • Define research project requirements through categorizing research problem, formulate research subjects and hypothesis • Use bibliometric services • Design a small-scale research project • Analyze and discuss research results • Design research report, evaluate, and interpolate the results • Communicate effectively and professionally through writing, speaking, and listening. • Construct a career development plan (roadmap) that outlines a path to a chosen career by delineating the skills required for the type of job, recognizing individual skill strengths and gaps, and identify activities that can be used to acquire the skills associated with the gaps. • Explain the value of networking strategies relevant to professional development; apply networking strategies to demonstrate effective networking conversations and written communications. • Demonstrate the skills needed to create, format and tailor a professional resume.
Syllabus (List Of Lessons)	• Research (Meaning of the research, Research aims, Characteristics of the research, Research types, Categories of research, Rresearch quality, Bibliometric services) • Research process (Problem identification, Choice of the title, Hypothesis formulation, Formulation of the research plan, Literture collecting and analysis, Solving the research problem, Research report, Formulation and exploaration of the research results) • Research article (Framework for research paper, Basic principles, Figures and tables, Title, Abstract, Collaborative writhening, Citing sources, Journal choosing, Paper submition, Review process and Response to reviews) • Communicating research (Preparing publication, Seminars and conference presentations, Working with research team, Ethics in research) • Leadership (Learning Competency Model, the Notebook, Term Project). • Networking, Power Statements, Networking Conversations • Resume writing, Preparation for Interviews, Researching Jobs and Designing a Career • Business Communication, Relationship Building, Managing Your Manager • Presentation Skills
Prerequisite	None
Course Literature	• Sally J. Zepeda (2012), **Professional Development: What Works**, Volume 1, Taylor and Francis, USA. • Ranjit Kumar (2014), **Research Methodology**, Fourth Edition, SAGE, USA. • Barbara Gastel , Robert A. Day (2016), **How to Write and Publish a Scientific Paper**, Eighth Edition, GreenWood, USA.

Course Name	Hyper-Spectral and 3D Remote Sensing
Credit Hours	3 CH (11 ECTS credits): 2 CH theoretical + 1 CH Practical
Course Description	Hyperspectral remote sensing fundamentals, data gathering and preprocessing, data analysis and applications, and validation of the results. Active sensors Fundamentals, active sensors (RADAR and LIDAR) data gathering, preprocessing, data analysis and applications, Validation of the results. Advanced remote sensing applications including project definition, workflow, database, preprocessing, information extraction, validation and accuracy assessment.
Learning Outcomes	After completing the course, students will be able to: • Explain the basics of 3D Remote Sensing with active and passive sensors. • Manage in the acquisition, pre-processing, classification, validation and/or change detection of Radar images, hyperspectral and LiDAR data. • Design a workflow to process hyperspectral data or data from an active sensor. • Acquire and process data in order to develop a remote sensing project using remotely sensed imagery from an active or hyperspectral sensor.
Syllabus (List Of Lessons)	• Hyperspectral remote sensing: Fundamentals. • Hyperspectral remote sensing: data gathering and preprocessing. • Hyperspectral remote sensing: data analysis and applications. Validation of the results. • Active sensors: Fundamentals. Active sensors (RADAR): data gathering, pre-processing, data analysis and applications, Validation of the results. • Advanced remote sensing applications: project definition, Workflow, Database, Preprocessing. Information extraction, Validation and accuracy assessment.
Prerequisite	None
Course Literature	• Ruiliang Pu (2017), **Hyperspectral Remote Sensing: Fundamentals and Practices**, Taylor and Francis, USA. • Marcus Borengasser and William S. Hungate (2017) **Hyperspectral Remote Sensing: Principles and Applications**, Second Edition. • Matthew J. McGill, NASA Technical Reports Server (NTRS) (2013), **Lidar Remote Sensing**, NASA, USA.

Course Name	Geospatial Database
Credit Hours	3 CH (11 ECTS credits): 2 CH theoretical + 1 CH Practical
Course Description	Fundemetals of Databases and geospatial databases, database management system, GIS. Interoperability. Modelling, Semi-structured data types and data, Relational model, SQL, Object-oriented, Diagrams of the development cycle. Object modelling using class diagrams. Unconformity of programming languages,
Learning Outcomes	After completing the course, students will be able to: • Define the terms related to geospatial databases. • Independently analyse the use of geospatial databases. • Recognize and use object-oriented database in the geodetic environment
Syllabus (List Of Lessons)	• Introduction to Databases • Data models and DBMS • GIS. Interoperability. • Semi-structured data types • Relational model • SQL and Object-oriented (OO) analysis and design. • UML - goals. UML diagrams and SDLC. • Object modelling using class diagrams. • Object-oriented concepts • Unconformity of programming languages.
Prerequisite	None
Course Literature	• Emmanuel Stefanakis (2014), **Geographic Databases and Information Systems**, CreateSpace Independent Publishing Platform, North Charleston, SC. • David Arctur, Michael Zeiler (2014), **Designing Geodatabases: Case Studies in GIS Data Modeling,** ESRI, USA. • Hussein Nasser (2014), **Learning ArcGIS Geodatabase**, PacktPub, USA.

Course Name	GIS and GNSS Projects
Credit Hours	3 CH (11 ECTS credits): 2 CH theoretical + 1 CH Practical
Course Description	This course is based on project plan through stating working groups, defining project target, GNSS Data Collection, Data Processing, and GNSS Integration and Applications. In addition, the course focuses on GIS Project Design, GIS implementation and analysis, and Projects Presentations.
Learning Outcomes	The students will be able to: • Describe and apply the procedures for gathering and integrating GNSS data in GIS environment. • Evaluate and compare different methodologies for GNSS and GIS data processing. • Analyze the geospatial information using GIS software. • Design and manage a GIS project in the field of natural resources for real life problems.
Syllabus (List Of Lessons)	• GNSS Data Collection • GNSS Data Processing • GNSS Data Integration and Applications • GIS Project Design • GIS implementation and analysis • Project Presentations
Prerequisite	-
Course Literature	• Elliott Kaplan, Christopher J. Hegarty (2017), **Understanding GPS/GNSS: Principles and Applications,** Third Edition, Artech House, USA. • Pratap Misra, Per Enge (2012), **Global Positioning System: Signals, Measurements, and Performance,** Second Edition, Ganga-Jumuna Press, USA. • European Space Agency (ESA) (2006), EGNOS: **The European Geostationary Navigation Overlay System: A Cornerstone of Galileo**, ESA Publications, EU.

Course Name	Geospatial Data Analysis
Credit Hours	2 CH (7.2 ECTS credits): 1 CH theoretical + 1 CH Practical
Course Description	Implementation of spatio-temporal analyses and spatial statistics including exploratory analysis, data visualisation, spatial autocorrelation and spatial regression, point and areal pattern analysis , analytical methodologies and model building , distance and directional analysis, geometrical processing, map algebra, and grid models, surface analysis, including surface form and flow analysis, gridding and interpolation methods, and visibility analysis , and network and locational analysis.
Learning Outcomes	After completing the course, students will be able to: • Model and present numerically the structure of spatial correlation of observed phenomena. • Apply geostatistical interpolation methods for real-world problems. • Describe and apply change-detection techniques. • Use mainstream software tools (commercial or open-source) to solve spatial problems. • Write a report and prepare a presentation with the results of performing spatial analyses
Syllabus (List Of Lessons)	• Concepts in spatio-temporal analyses and spatial statistics • Exploratory Spatial and Spatio-temporal Data Analysis and Data Visualisation • Spatial Statistics including Spatial Autocorrelation and Spatial Regression • Point and Areal Pattern Analysis • Analytical methodologies and model building • Core components of spatial analysis, including distance and directional analysis, geometrical processing, map algebra, and grid models • Surface analysis, including surface form and flow analysis, gridding and interpolation methods, and visibility analysis • Network and locational analysis, including shortest path calculation, travelling salesman problems, facility location and arc routing • Data Science and Analytics for Big Data
Prerequisite	**Data Mining**
Course Literature	• Yongwan Chun, Daniel A. Griffith (2013), **Spatial Statistics and Geostatistics**, SAGE Publications Ltd. • Hans Wackernagel (2003)**, Multivariate Geostatistics: An Introduction with Applications,** Third Edition, Springer.

Course Name	Risk Assessment of Natural Hazards
Credit Hours	3 CH (11 ECTS credits): 2 CH theoretical + 1 CH Practical
Course Description	The course will be based on problem solving project. The project will be dealt with emphasis on risk management concepts starting from defining problem, setting road map, data collection and database construction, spatial modelling and simulation, assessing and visualizing the risk vulnerability. Based on the problem project outputs, students will set appropriate adaptation and mitigation action plans, and present their interpretation and reporting the final results.
Learning Outcomes	After completing the course, the students will be able to: • Describe and apply the procedures for gathering and integrating geo-informatics data on natural risk problem as associated with landslides, floods, and droughts. • Evaluate and compare different geodata processing methodologies for vulnerability assessment. • Model and simulate the geospatial information using GIS software. • Set mitigation recommendations based on visual risk maps. • Design and manage a GIS project in the field of natural resources for real life problems.
Syllabus (List Of Lessons)	• Risk management concepts • Defining problem and setting road map especially for landslides, floods, and drought. • Data collection and database construction • Spatial modelling and simulation • Assessing and visualizing the risk vulnerability • Setting the appropriate adaptation and mitigation action plans • Interpretation and reporting of results
Prerequisite	Geospatial data analysis and GIS and GNSS Projects
Course Literature	• Hamid Reza Pourghasemi, Mauro Rossi (2018), **Advances in Natural and Technological Hazards Research**, Springer. • Biswajeet Pradhan, Manfred Buchroithner (2012), **Terrigenous Mass Movements: Detection, Modelling, Early Warning and Mitigation Using Geoinformation Technology**, Springer.

Course Name	GIS Applications for Land Management
Credit Hours	3 CH (11 ECTS credits): 2 CH theoretical + 1 CH Practical
Course Description	The course will be based on problem solving project. The project will be dealt with emphasis on land management concepts starting from defining problem, setting road map, data collection and database construction, spatial modelling and simulation, assessing and visualizing the risk vulnerability. Based on the problem project outputs, students will set appropriate adaptation and mitigation action plans, and present their interpretation and reporting the final results.
Learning Outcomes	After completing the course, the students will be able to: • Describe and apply the procedures for gathering and integrating geo-informatics data for land management • Evaluate and compare different geodata processing methodologies for land management. • Model and simulate the geospatial information using GIS software. • Set recommendations based on visual maps. • Design and manage a GIS project in the field of land management for real life problems.
Syllabus (List Of Lessons)	• Land management concepts (soil survey and landuse, Land Use Land Cover, crop evapotranspiration estimation, soil erosion control, crop productivity, irrigation management, soil salinity management, urban planning, etc) • Defining problem and setting road map especially for land management • Data collection and database construction • Spatial modelling and simulation • Assessing and visualizing • Setting the appropriate action plans • Interpretation and reporting of results
Prerequisite	Geospatial data analysis and GIS and GNSS Projects
Course Literature	• David E. Clay, John F. Shanahan (2011), **GIS Applications in Agriculture**, CRC Press. • Kandi Brown , William L Hall , Marjorie Hall Snook , Kathleen Garvin (2010), **Sustainable Land Development and Restoration: Decision Consequence Analysis**, Butterworth-Heinemann. • Robert Scally (2006), **GIS for Environmental Management**, ESRI.

Course Name	Water Resources Management using Geo-informatics
Credit Hours	3 CH (11 ECTS credits): 2 CH theoretical + 1 CH Practical
Course Description	The course will be based on problem solving project. The project will be dealt with emphasis on water resources management concepts starting from defining problem, setting road map, data collection and database construction, spatial modelling and simulation, assessing and visualizing the risk vulnerability. Based on the problem project outputs, students will set appropriate adaptation and mitigation action plans, and present their interpretation and reporting the final results.
Learning Outcomes	After completing the course, the students will be able to: • Describe and apply the procedures for gathering and integrating geo-informatics data for water resources management • Evaluate and compare different geodata processing methodologies for water resources management. • Model and simulate the geospatial information using GIS software. • Set recommendations based on visual maps. • Design and manage a GIS project in the field of water resources management for real life problems.
Syllabus (List Of Lessons)	• Water Resources management concepts (surface and groundwater resources allocation, watershed modelling, water quality control, natural and artificial recharge, water harvesting, etc) • Defining problem and setting road map especially for Water Resources management • Data collection and database construction • Spatial modelling and simulation • Assessing and visualizing • Setting the appropriate action plans • Interpretation and reporting of results
Prerequisite	Geospatial data analysis and GIS and GNSS Projects
Course Literature	• S.S. Asadi (2018), **Geospatial data analysis and modelling for water quality management**, LAP LAMBERT Academic Publishing. • Gert A. Schultz , Edwin T. Engman (2011), **Remote Sensing in Hydrology and Water Management**, Springer. • Barnali Dixon, Venkatesh Uddameri (2016), **GIS and Geocomputation for Water Resource Science and Engineering**, American Geophysical Union.

Course Name	Geological Applications using Geo-informatics
Credit Hours	3 CH (11 ECTS credits): 2 CH theoretical + 1 CH Practical
Course Description	The course will be based on problem solving project. The project will be dealt with emphasis on geological applications concepts starting from defining problem, setting road map, data collection and database construction, spatial modelling and simulation, assessing and visualizing the risk vulnerability. Based on the problem project outputs, students will set appropriate adaptation and mitigation action plans, and present their interpretation and reporting the final results.
Learning Outcomes	After completing the course, the students will be able to: • Describe and apply the procedures for gathering and integrating geo-informatics data for geological applications • Evaluate and compare different geodata processing methodologies for geological applications. • Model and simulate the geospatial information using GIS software. • Set recommendations based on visual maps. • Design and manage a GIS project in the field of geological applications for real life problems.
Syllabus (List Of Lessons)	• Geological applications concepts (geological mapping, structural mapping, ore explorations, geological mining, etc) • Defining problem and setting road map especially for geological applications • Data collection and database construction • Spatial modelling and simulation • Assessing and visualizing • Setting the appropriate action plans • Interpretation and reporting of results
Prerequisite	Geospatial data analysis and GIS and GNSS Projects
Course Literature	• Ravi P. Gupta (2017), **Remote Sensing Geology**, Springer. • S. M. Gandhi, B. C. Sarkar (2016), Essentials of Mineral Exploration and Evaluation, Elsevier. • E.J.M. Carranza (2008), **Geochemical Anomaly and Mineral Prospectivity Mapping in GIS**, Elsevier Science. • Gülcan Sarp (2012), **Lineament Analysis Of Landsat ETM Data For Geological Applications: Remote Sensing for Active Tectonics**, LAP LAMBERT Academic Publishing

Course Name	GIS Web and Mobile Applications
Credit Hours	3 CH (11 ECTS credits): 2 CH theoretical + 1 CH Practical
Course Description	Professionalizing WEB GIS through understanding and practicing web GIS structuring, processing, applications, and implementations with emphasis on networks and the Internet, Client-server architecture and distributed system architecture, client-side programming, distributed GIS architecture, Web GIS services, commercial and open-source software and tools , Spatial data management , quality and safety , mobile GIS and real-time GIS.
Learning Outcomes	After completing the course, students will be able to: • Use Web GIS to deliver authoritative maps, analytics, and geographic information to a wider audience, using lightweight clients and custom apps on web and smart devices. • Describe the distributed GIS architecture, components and development. • Compare Commercial and open-source software, tools and components for developing Web GIS applications • Differentiate between Web GIS services. • Apply web GIS to theoretical and practical cases. • Evaluate the quality and safety aspects of distributed GIS
Syllabus (List Of Lessons)	• WEB GIS Introduction (definitions, basic components and applications). • Basics of networks and the Internet (communication models, protocols, LAN, WAN). • Client-server architecture and distributed system architecture (Web client-server architecture, DCOM, NET, CORBA, Java). • Basics of client-side programming (HTML, CSS, DOM, JavaScript). • Basics of server-side programming. • Distributed GIS architecture, components and development. • Web GIS services (WMS, WMTS, WFS, WFS-T, WCS and WPS). • Standards for distributed GIS services. • Commercial and open-source software, tools and components for developing Web GIS applications. • Spatial Data Management in order to understand the basics of RDBMS. • Aspects of quality and safety for distributed GIS. • Distributed GIS applications. Mobile GIS and real-time GIS • List of Seminars (to be decided according of level of the students and GIS programs to be used)
Prerequisite	Geospatial data analysis and GIS and GNSS Projects
Course Liteature	• Eric Pimpler, Mark Lewin (2017), **Building Web and Mobile ArcGIS Server Applications with JavaScript,** Second Edition, Packt Publishing. • Rene Rubalcava (2014), **ArcGIS Web Development**, Manning Publications.

Thesis 9 Credit Hours
This course is to enable the student to work on his specific thesis through field and office work