Asian Institute of Technology
School of Engineering and Technology

AT76.20 ***GIS Programming and Modeling 3*** **(2 - 3)** **Semester: Intersem**

Course Objective: This course aims at providing advance knowledge in spatial data understanding, analysis and programming skill in GIS environment. Students will also be exposed to advance geoprocessing and modeling techniques, exploratory geostatistical analysis and spatial data analysis to impart advance knowledge of programming, customization and automation in GIS.

Learning Outcomes:

The students on the completion of this course would be able to:

1. Perform object-oriented programming tasks in GIS using Python;
2. Analyze GIS-model interactions and design procedures for modeling with GIS;
3. Develop their own tools for geospatial analysis;
4. Develop GIS-based models in Python for various applications integrated with ArcGIS;
5. Describe general software engineering concepts and good programming methods and practices; and
6. Critically evaluate different methodologies for developing applications in GIS; x

Pre-requisite: AT76.01 Geographic Information Systems

Course Outline:

I. Introduction and Overview
   1. Computer hardware and software for GIS
   2. GIS and Programming
   3. Python Programming Introduction
   4. Class and Objects
   5. GIS Data Models

II. Object Oriented Programming
   1. Python Scripting
   2. Class and Objects
   3. Point, Polyline and Polygon

III. Python Programming Structure
   1. Object Oriented Approach
   2. Programming Syntax
   3. Data Types
   4. Variables, Functions and Code style
   5. Operators and Statements

6. Python Language Control Structure

IV. Vector Data Visualisation
1. GIS Vector Data Visualisation
i) Programming Thinking, Problem Analysis and Implementation

V. Vector Data Algorithm
1. Centroid – of triangle, rectangle and polygon
2. Area – simple and composite polygon
3. Length – straight and polyline segments
4. Lines Intersection – parallel and vertical lines
5. Points and Polygon – drawing and developing solutions to complex scenarios

VI. Advanced GIS Algorithms and Programming using Python
1. Introduction to ArcPY
2. Automating Arc Tools with Python
3. Data accessing and editing
4. Data Manipulation and Complex Objects
5. Automating Map Production
6. Implementing Spatial Relationship Calculations

VII. Raster Data Algorithm
1. Raster Data
2. Data Storage and Compression
3. Raster Data Format and Definitions
4. Choropleth Mapping
5. Advance Tools for Raster Spatial Analysis

VIII. Surface Data Algorithm
1. 3D Surface Data Models – types
2. Developing Models Using Discrete and Continuous Data
3. Triangulated Irregular Network Modeling
4. Point to Grid Surface Modeling
5. Creating Surfaces for slopes, elevations, aspects and hydrologic data analysis

IX. Network Data Algorithm
1. Network Representation
2. Directed and Unidirected Network
3. Finding Shortest Path
4. Network Analysis

X. Advance Applications in Environment and Climatic Data using Python Programming
1. Introduction
2. Environmental Application using Various Indices

3. Climate Data Manipulation and Change Analysis

Laboratory session(s):

1. Overview of Arc GIS advance tools
2. Customization and automation in ArcGIS using model builder
3. Introduction to ArcPY extension
4. Introduction to Python scripting in GIS
5. Python based modeling in GIS
6. Database access and editing
7. Creating GIS tools using Python Programming
8. Vector Data Algorithm implementation using ArcPY
9. Raster Data Algorithm implementation using ArcPY
10. Application Development Exercise
11. Miniproject planning and proposal development

Learning Resources:

Textbook(s):

Chaowei Yang.:
Introduction to GIS Programming and Fundamentals with Python and ArcGIS, CRC Press, Taylor and Francis Group, U.K, 2016.

Reference Books:

Allen, David.:
Getting to Know ArcGIS ModelBuilder, Esri Press., Redlands, 2011.
http://esripress.esri.com/display/index.cfm?fuseaction=display&websiteID=195&moduleID=0.

Shaw, Zed A.:
Learn Python the Hard Way, Second Edition, Shavian Publishing, LLC, , 2011.
http://learnpythonthehardway.org/book/.

Zandbergern, Paul A.:
Python Scripting for ArcGIS, Esri Press., Redlands, 2013.
http://esripress.esri.com/display/index.cfm?fuseaction=display&websiteID=224&moduleID=0.

Downey, Allen:
Think Python - How to Think Like a Computer Scientist, Version 2.0.1. Green Tea Press. Needham, Massachusetts, 2012.
http://www.greenteapress.com/thinkpython/thinkpython.pdf.

Journals and Magazines:

International Journal of GIS, Taylor & Francis
International Journal of Geoinformatics, Association of Geoinformation Technology

Others:

Lecture notes and other ancillary learning resource books will be provided

Teaching and Learning Methods: This course is blend of learning concepts and hands on exercises for developing the skills to apply various software related to GIS and also implement advance modeling through programming in GIS. Each class will comprise of conceptual and knowledge development lectures and discussions which will be followed by hands on exercises and assignments.

Laboratory Sessions: Laboratory exercises will expose students to different advance tools in GIS, other modeling software and analysis techniques. Students have to submit all assignments individually. **S**tudents have to do a miniproject demonstrating the skill gained in this subject. Assignments are given to assess the understanding of concept, analysis methods and modeling to be applied in advance spatial analysis methods and applications development.
Discussion Sessions: Every class will have discussion sessions to engage all the students.

Time Distribution and Study Load:

Lecture: 30 Hrs
Laboratory: 45 Hrs
Miniproject: 20 Hrs
Self-studies: 90 Hrs

Evaluation Scheme:

The final grade will be based on the following weight distribution: lab assignments (25%), midsem exam (15%), final exam (25%) and Mini Project (35%). Closed book examinations are used for both midsem and final exams.

An "A" would be awarded if a student can show the ability of having extensive knowledge on in all learning outcomes and ability to display excellent performance in midsem and final examinations, laboratory assignments and miniproject. A "B" would be awarded if a student shows an overall understanding of the topics covered, a "C" would be given if a student meets below expectation on both knowledge and practical skills acquired in laboratory exercises and miniproject. A "D" would be given if a student does not meet basic expectations of the topics presented in the course.

Instructor: Prof. Nitin K. Tripathi

School Recommendation: _____ ADRC Approval: 10 April, 2019

Academic Senate Approval: 24 April, 2019