Course title: Urban Systems Modelling

Course code: MEU 183	**No. of credits:** 2	**L-T-P:** 22-0-16	**Learning hours:** 38

Pre-requisite course code and title (if any): Basic knowledge of statistics and GIS

Department: Sustainable Engineering

Course coordinator: Dr Deepty Jain	**Course instructor:** Dr Deepty Jain

Contact details: deepty.jain@terisas.ac.in

Course type: Compulsory	**Course offered in:** Semester 3

Course Description

Urban areas or cities are dynamic and complex systems that also exhibit a self-organizing behaviour. The complex urban system has various inter-related subsystems like population, housing, transport, water and climate. It is difficult to envisage the changing development patterns of a city, as it is an outcome of these interacting sub-systems and externalities (policies, climate change and disasters). Therefore, the impact of these development patterns on economy, society and environment is uncertain. In semester 1 and semester 2, UDM curriculum expands the knowledge of observing, measuring, analysing, describing and visualizing important processes taking place in urban regions, using statistical and spatial-analytical methods and techniques. The students have also gained an exposure on various aspects of urban development and management like theories of urbanization, services, ecology, city competitiveness, urban finance and policies. This course will develop an understanding of methods, models and simulations applied for problem solving, better decision making and simulating urban changes. The students through the course will have an edge on understanding urban complexities, interactions between systems and therefore envisage development in lieu of certain policy changes.

Course objectives

1. To equip students with the concept of system theories and dynamic system approaches
2. To enable students to study interactions between urban sub-systems
3. To provide hands on experience on urban system models and simulations

Course content

Module	Topic	L	T	P
1.	Module 1: Urban systems, complexities and inter-linkages between subsystems a) Complexity, system theory and system dynamic approach for urban systems b) System quantification to study interactions for urban areas like infrastructure supply, accessibility, affordability (ArcGIS) c) Discrete choice models and quantification of interactions between systems like relocation models, choice models (SPSS/ Stata/ArcGIS)	11		4
2.	Module 2: Urban models and simulations a) Concept of modelling, simulation and flavours of models – static and dynamic models, aggregated vs disaggregated models, simulations b) Conventional and New generation models like cellular automata, agent based models and flow dynamics c) Land use and Urban Development model and simulations (hands on exercise on METRONAMICA/SLEUTH/ CLUE-S)	9		12
3.	Module 3: Managing uncertainty and data limitations a) Uncertainty in urban systems and its impact on models, scenarios and solution findings b) Methods to manage uncertainty and data limitations	2		
	Total	**22**		**16**

Evaluation criteria

- Assignment*s: 30%
- Project work**: 30%
- Major Test: 40%

*Assignments- This shall cover review of urban models, quantification of factors and development of residential choice models

**Project Work-This shall include development of an urban simulation, scenarios and estimating impacts on simulation results

Learning outcomes

On successfully completing this course the students will be able to:

1. Quantify interactions between drivers and sub-systems of urban system
2. Anticipate impact of alternate development strategies on futures 3. Develop models and simulations for urban systems

Pedagogical approach

The course will be delivered through class-room teaching, research-based discussions, case-study of applied methodologies and hands-on-experience on statistical tools (Stata), GIS applications (Arc Map) and urban simulations like METRONAMICA/SLEUTH/CLUE-S.

Essential Reading Material – Books

1. Batty, Michael. Cities and complexity: understanding cities with cellular automata, agentbased models, and fractals. 2007. The MIT press. (Chapter 1 to chapter 6)
2. Train, K.E., 2009. Discrete choice methods with simulation. Cambridge university press. (Chapter 3 – Logit)
3. Field, A., 2013. Discovering statistics using IBM SPSS statistics. Sage. (Chapter 8 - Logistic regression)

Essential Reading Material - Papers

1. Michael Wegener, New spatial planning models, International Journal of Applied Earth Observation and Geoinformation, Volume 3, Issue 3, 2001, Pages 224-237, ISSN 0303- 2434, http://dx.doi.org/10.1016/S0303-2434(01)85030-3.

Preferred Reading Material – Papers

1. Aguayo, Mauricio, et al. "Revealing the driving forces of mid-cities urban growth patterns using spatial modelling: a case study of Los Ángeles, Chile." Ecology and Society 12.1 (2007).
2. Barredo, J.I., Kasanko, M., McCormick, N. and Lavalle, C., 2003. Modelling dynamic spatial processes: simulation of urban future scenarios through cellular automata. Landscape and urban planning, 64(3), pp.145-160.
3. Benguigui, L., Czamanski, D. and Marinov, M., 2001. The dynamics of urban morphology: the case of Petah Tikvah. Environment and planning B: Planning and design, 28(3), pp.447- 460.
4. Castle, C.J. and Crooks, A.T., 2006. Principles and concepts of agent-based modelling for developing geospatial simulations.
5. Chengxiang Zhuge, Chunfu Shao, Jian Gao, Chunjiao Dong, Hui Zhang, Agent-based joint model of residential location choice and real estate price for land use and transport model, Computers, Environment and Urban Systems, Volume 57, May 2016, Pages 93- 105.
6. Meimei Wang, Yongchun Yang, Shuting Jin, Lei Gu, Heng Zhang, Social and cultural factors that influence residential location choice of urban senior citizens in China – The case of Chengdu city, Habitat International, Volume 53, April 2016, Pages 55-65
7. Mohamed R. Ibrahim, How do people select their residential locations in Egypt? The case of Alexandria, Cities, Volume 62, February 2017, Pages 96-106

Additional information (if any)

Student responsibilities

Attendance, feedback, discipline, guest faculty etc.

Courses Reviewers

1. Course Reviewers: Dr. Talat Munshi, Technical University of Denmark, København
2. Dr. Jay Mittal, Department of Political Science, Auburn University.
3.