Course syllabus

Kritiska Infrastrukturers resiliens
Critical Infrastructure Resilience

VRSN45, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED BI/RH
Date of Decision: 2023-04-12

General Information

Main field: Disaster Risk Management and Climate Change Adaptation.
Elective for: RH4, MKAT2, R4
Language of instruction: The course will be given in English

Aim

- prepare the students so that they are able to work with critical infrastructures topics within for example private business, government agencies or nongovernmental organization.
- provide a foundation for students interested in further studies and research on critical infrastructure topics.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- demonstrate an overall understanding of the form and function of various critical infrastructures, technical as well as organizational aspects.
- demonstrate an understanding of the conditions and challenges for analysis, planning and management of critical infrastructures.
- demonstrate an understanding of how concepts and methods in the area of critical infrastructure management relate to each other and can be applied in a practical context.

Competences and skills
For a passing grade the student must

- demonstrate ability to analyse critical infrastructures and their interdependencies, as well as apply methods and evaluate strategies for ensuring function in these types of systems.
- demonstrate ability to communicate and discuss their conclusions orally and in writing, reflecting on the underlying knowledge, results and arguments.
- demonstrate ability to plan, implement and report project tasks and project work and in connection with this also demonstrate ability for teamwork and collaboration.
- demonstrates ability to identify, understand and reflect on scientific publications relevant to the subject area.

Judgement and approach
For a passing grade the student must

- demonstrate ability to analyse and reflect on infrastructural and societal aspects regarding critical infrastructure management.
- demonstrate ability to reflect on their own needs for further development of knowledge and competence.

Contents

The course introduces and discusses important aspects for management of critical infrastructure, such as power systems, water supply systems, telecommunication systems and transport systems. The course should be seen as an introduction to the subject of critical infrastructure and vital societal functions. Important aspects covered are the form and function of critical infrastructures and their role in society as well as key methods and concepts for analysis and management of critical infrastructures. Methods covered in the course include: network theory as an analysis tool for complex infrastructure systems, risk management, asset management, infrastructure interdependency modelling, and impact assessments of large-scale infrastructure disruptions. Concepts that are important for the student to understand and reflect on during the course are for example: risk, reliability, uncertainty, resilience, complexity and continuity. An important part of the learning process is that students will apply concepts and methods to realistic representations of infrastructures as well as to connect to and reflect on the different concepts and methods.

Throughout the course, there is a progression from abstract to more realistic representations of infrastructures, where the student will reflect on the different strengths and weaknesses of different models, methods and concepts. The course is hence divided into a number of parts that guide the student through important concepts and methods. To each central part, computer labs are used to enable students to apply the various methods introduced in the course. Teacher-led seminars for each central part of the course are also given, where students can actively discuss and reflect on the theme and the literature as well as compare approaches for problem solving.

Examination of the course takes place through essays that deal with the different central parts of the course as well as a final project work in which either one or more central parts of the course are explored in more depth or a synthesis of all parts of the course is presented (i.e. each central part covered becomes input values for the final project work). The project is discussed in a teacher-led seminar so that the students also can acquire the ability to verbally present and discuss their approaches and preliminary results, as well as provide constructive feedback.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: The exam is a compilation of written essays for the project assignments as well as a written final project essay. For an approved grade, active participation is required for the mandatory parts of the course. The project work must be presented both verbally and in writing.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0119. **Name:** Assignment Reports.
Credits: 5. **Grading scale:** TH. **Assessment:** Approved written report **Contents:** Written individual project assignments report
Code: 0219. **Name:** Project Report.
Credits: 2,5. **Grading scale:** TH. **Assessment:** Approved ritten report and oral presentation **Contents:** Written individual project report and oral presentation

Admission

Admission requirements:

- EXTA60 Statistics or FMS012 Mathematical Statistics, Basic Course or FMS032 Mathematical Statistics, Basic Course or FMS035 Mathematical Statistics, Basic Course or FMS140 Mathematical Statistics, Basic Course or FMSF20 Mathematical Statistics, Basic Course or FMSF45 Mathematical Statistics, Basic Course or FMSF50 Mathematical Statistics, Basic Course or FMSF55 Mathematical Statistics, Basic Course or FMSF70 Mathematical Statistics or FMSF75 Mathematical Statistics, Basic Course or FMSF80 Mathematical Statistics, Basic Course
- FMA415 Calculus in One Variable or FMA430 Calculus in Several Variables or FMA435 Calculus in Several Variables or FMAA01 Calculus in One Variable or FMAA05 Calculus in One Variable or FMAB30 Calculus in Several Variables or FMAB35 Calculus in Several Variables or FMAB45 Calculus in One Variable A1 or FMAB50 Calculus in One Variable A2 or FMAB60 Calculus in One Variable A3 or FMAB65 Calculus in One Variable B1 or FMAB70 Calculus in One Variable B2

Assumed prior knowledge: Basic knowledge of programming. A minimum of 150 credits from a five-year engineering programme or from the Fire Safety Engineering Programme at LTH or equivalent educational background and academic credits for incoming exchange students.
The number of participants is limited to: 20
Selection: Completed university credits within the program. Within programs where the course is given as a compulsory course students are guaranteed admission. Thereafter priority is given to students enrolled in programs that include the course in the curriculum.
The course might be cancelled: If the number of applicants is less than 12.

Reading list

- Communication from the commission: on a European Programme for Critical Infrastructure Protection. Commission of the European communities, 2006. COM(2006) 786 final.
- Concerning measures for a high common level of security of network and information systems across the Union. The European Parliament and of the council, 2016. Directive (EU) 2016/1148.

- Fritzon, Å., Ljungkvist, K., Boin, A., & Rhinard, M.: Protecting Europe's critical infrastructures: problems and prospects. Journal of Contingencies and Crisis Management, 2007. 15(1), 30-41.
- Brown, K. A.: Critical path: a brief history of critical infrastructure protection in the United States. Spectrum Publishing Group, Incorporated, 2006.
- Protection of Vital Societal Functions & Critical Infrastructure: Fact sheet. Swedish Civil Contingencies Agency, Karlstad., 2016. MSB939.
- Failure to Act: Closing the Infrastructure Investment Gap for America's Economic Future. American Society of Civil Engineers, 2016. Reston, VA, USA.
- Newman, M.E.: The structure and function of complex networks. SIAM Review, 2003. Vol. 45, No. 2, pp.167–256.
- Strogatz, S.: Exploring Complex Networks. Nature, 2001. Vol. 410, pp. 268-276.
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- Johansson, J., Hassel, H., & Zio, E.: Reliability and vulnerability analyses of critical infrastructures: comparing two approaches in the context of power systems. Reliability Engineering & System Safety, , 2013. Vol. 120, pp. 27-38.
- Zio, E.: Challenges in the vulnerability and risk analysis of critical infrastructures. Reliability Engineering & System Safety, 2016. Vol. 152, pp. 137-150.
- Johansson, J., Jonason Bjärenstam, R., Axelsdóttir, E.: Contrasting critical infrastructure resilience from Swedish infrastructure failure data. Safe Societies in a Changing World, Proceedings of ESREL 2018, , 2018. Trondheim, Norway, June 17-21.
- Koppenjan, J. F., & Enserink, B.: Public–private partnerships in urban infrastructures: reconciling private sector participation and sustainability. Public Administration Review, 2009. Vol. 69(2), pp. 284-296.
- Moteff, J.: Risk management and critical infrastructure protection: Assessing, integrating, and managing threats, vulnerabilities and consequences. Library of Congress Washington DC Congressional Research Service., 2005.
- Too, E. G.: A framework for strategic infrastructure asset management. In Definitions, concepts and scope of engineering asset management. Springer, London., 2010. Pp. 31-62.
- Schneider, J., Gaul, A. J., Neumann, C., Hogräfer, J., Wellßow, W., Schwan, M., & Schnettler, A.: Asset management techniques. International Journal of Electrical Power & Energy Systems, 2006. Vol. 28(9), pp. 643-654.
- Rinaldi, B.S.M., Peerenboom, J.P. & Kelly, T.K.,: Identifying, Understanding, and Analyzing Critical Infrastructure Interdependencies. IEEE Control Systems Magazine, , 2001. Vol. 21(6), pp.11– 25.
- Rinaldi, S. M.: Modeling and simulating critical infrastructures and their interdependencies. Proceedings of the 37th annual Hawaii international conference on System Sciences, IEEE, 2004. Pp. 1-8.
- Buldyrev, S. V., Parshani, R., Paul, G., Stanley, H. E., & Havlin, S.: Catastrophic cascade of failures in interdependent networks. Nature, 2010. Vol. 464, pp. 1025-1028.
- Johansson, J., & Hassel, H: An approach for modelling interdependent infrastructures in the context of vulnerability analysis. Reliability Engineering & System Safety, , 2010. Vol. 95(12), pp. 1335-1344.
- Ouyang, M.: Review on modeling and simulation of interdependent critical infrastructure systems. Reliability engineering & System safety, , 2014. Vol. 121, pp. 43-60.
- Thacker, S., Pant, R., & Hall, J. W.: System-of-systems formulation and disruption analysis for multi-scale critical national infrastructures. Reliability Engineering & System Safety, , 2017. Vol. 167, pp. 30-41.
- Boin, A., & McConnell, A.: Preparing for critical infrastructure breakdowns: the limits of crisis management and the need for resilience. Journal of Contingencies and Crisis Management, 2007. Vol. 15(1), pp. 50-59.

- Little, R. G.: Toward more robust infrastructure: observations on improving the resilience and reliability of critical systems. Proceedings of the 36th Annual Hawaii International Conference on System Sciences, IEEE, 2003. Pp. 1-9.
- Ouyang, M., & Wang, Z.: Resilience assessment of interdependent infrastructure systems: With a focus on joint restoration modeling and analysis. Reliability Engineering & System Safety, , 2015. Vol. 141, pp. 74-82.
- Almklov, P., Antonsen, S., & Fenstad, J.: Post-disaster infrastructure restoration: A comparison of events for future planning. In Risk and Interdependencies in Critical Infrastructures , 2012. Pp. 211-225.
- Risk Management in Critical Infrastructures. Springer, London.

Contact and other information

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Course administrator: Linnéa Ekman, linnea.ekman@ebd.lth.se

Further information: The projects are encouraged to be done in cooperation between students. The students will, however, need to write individual project reports. One of the projects can be done as group work and reported jointly. If a joint report is submitted, each group member must be able to present and answer for the contents of the report. Active participation in group work is mandatory. Each group member must be able to present and answer for the contents of the joint report. A student who does not meet the demands of active participation, or disregard their obligations, can be replaced to another group or failed by the examiner.