# DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTING

**COURSE CATALOGUE 2022 / 2023**

**WINTER SEMESTER – *UNDERGRADUATE / BACHELOR***

| COURSE INFORMATION | |
|---|---|
| **Course name** | **Software Engineering Fundamentals** |
| **Degree** | Undergraduate |
| **Semester** | Winter |
| **ECTS points** | 5 |
| **Course status** | Compulsory |
| **Course leader** | Krunoslav Žubrinić, PhD, Asst. Prof. |
| Department, room no. | Electrical Engineering and Computing Department, Ćira Carića 4, D17 |
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| e-mail | krunoslav.zubrinic@unidu.hr |

## COURSE DESCRIPTION

**Course content**

Definition of software engineering. Basic methodologies and standard techniques of software development. Structural and object oriented methodologies. Software development process. Formal specifications. Standards in software development. Planning. System analysis and requirements gathering. System design. Building. Testing. Implementation. Reliability of software. Product and system quality. Data protection. Designing and managing a project. Standardization of documentation.

**Learning outcomes**

Students will be able to describe the process used to develop a simple real-world software system using engineering approach .12. Students will be able to demonstrate knowledge of user requirements, engineering, and analysis process (elicitation, analysis, specification, validation and verification).13. Students will be able to demonstrate basic knowledge of architectural design based on user requirements.14. Students will be able to demonstrate basic knowledge of component design based on user requirements and architecture.15.

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|---|---|
| Students will be able to demonstrate basic knowledge of testing strategies.16. Students will be able to implement, document and present simple software system using formal engineering approach. | |
| **TEACHING MODE** | |
| ☒Lectures<br>☐Seminars and workshops<br>☒Exercises<br>☒Independent assignments<br>☒Multimedia and internet<br>☐Distance learning | ☒Consultations<br>☐Laboratory<br>☐Field work<br>☒Mentoring<br>☒Exams |
| **EXAMINATION METHOD** | |
| ☒ Oral<br>☒ Written<br>☒ Partial exam | Other: |
| **READING** | |
| Compulsory reading | |
| 1. | A Concise Introduction to Software Engineering; P. Jalote; Springer; 2008; ISBN: 9781848003019 |
| 2. | Software engineering: A practitioner's approach, 7th edition; R. S. Pressman; McGraw-Hill; 2009; ISBN:9780073375977 |
| 3. | UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design 2nd ed; J. Arlow i I. Neustadt, Pearson education; 2005; ISBN: 9780321321275 |
| Optional reading | |
| 1. | SWEBOOK v3.0: Guide to the Software Engineering Body of Knowledge; P. Bourque and R. W. Fairley (ur.);IEEE; 2014; ISBN: 9780769551661; online: http://www.computer.org/portal/web/swebok/swebokv3 |

| | |
|---|---|
| 2. | Software engineering, 9th edition; I. Sommerville; Addison-Wesley; 2011; ISBN: 9780137035151 |

**LIST OF TOPICS**

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |
| 1. | Software engineering. Methodologies, process, development phases, methods and models. Project documentation. | **2** | **2** | |
| 2. | Software project. Planning. Building project plan. Tracking project progress. | **2** | **2** | |
| 3. | User requirements. Functional and nonfunctional. Requirement levels. Requirements engineering: Elicitation, analysis, specification, and validation of requirements for software. Standards. Use Case diagram. Analysis using MOSCOW/FURPS+ methodology. | **2** | **2** | |
| 4. | Functional and object oriented modeling. UML. UML diagrams. | **2** | **2** | |
| 5. | Software architecture. Elements: modules, components and connections. UML architecture diagrams. | **2** | **2** | |
| 6. | Software design. Coupling. Interfaces. Functional and OO design. OO design methodologies. UML package diagram. UML class diagram. | **2** | **2** | |
| 7. | OO design and modelling. Class and object. Relations among classes and objects. Abstraction. Encapsulation. Modularity. Hierarchy. UML object and sequence diagram. | **2** | **2** | |
| 8. | Detail design. System complexity. Design patterns. Levels of design patterns: high and low level. Examples of design patterns in programming language Java. UML decomposition and activity diagrams. | **2** | **2** | |
| 9. | Design patterns: Creational, structural and behavioral. Creational design patterns: Abstract factory, Builder, Factory method, Prototype, Singleton. Examples in programming language Java. | **2** | **2** | |
| 10. | Structural design patterns: Adapter, Bridge, Composite, Decorator, Façade, Flyweight, Proxy. Behavioral design patterns: Chain of responsibility, Command, Interpreter, Iterator, Mediator, Memento,Observer, State, Strategy, | **2** | **2** | |

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|---|---|---|---|---|
| | Template method, Visitor. Examples in programming language Java. | | | |
| 11. | Software testing. Testing in development and implementation phases. Black box. White box. Gray box. Functional testing. Requirements testing. Unit testing. Test automation. | **2** | **2** | |
| 12. | Software construction: coding, verification, unit testing and debugging. Version control. Connection between UML diagrams andsource code. | **2** | **2** | |
| 13. | Software implementation. Software documentation: user documentation, system documentation. Rules of writing good source code. Version control of documentation and source code. Version control systems. | **2** | **2** | |
| 14. | System integration. Methods of validation and verification. Integration testing. Requirements testing. Use case testing. User interface testing. Delivery. Continuous integration. | **2** | **2** | |
| 15. | Software maintenance. Maintenance types: corrective, corrective and predictive. Refactoring. Reengineering. | **2** | **2** | |
| | **TOTAL HOURS** | **30** | **30** | |

**OTHER RELEVANT INFORMATION**

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| COURSE INFORMATION | |
|---|---|
| **Course name** | **Communication Systems in Maritime Affairs** |
| **Degree** | Undergraduate |
| **Semester** | Winter |
| **ECTS points** | 6 |
| **Course status** | Compulsory |
| **Course leader** | Srećko Krile, PhD |
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| e-mail | srecko.krile@unidu.hr |

## COURSE DESCRIPTION

**Course content**

Telecommunication systems in maritime affairs. Basics of public and functional TK-networks. Transmission: mobile and physical access. Access networks and switching part. Computing networks and Internet. New services and counting in the context of NGN (New Generation Network). The role of functional networks in maritime affairs. Radio-communication networks: global and local coverage. Frequency distribution plan and channel division. Coverage, propagation characteristics, multiplexing and access. Analog AM (SSB) i FM modulation and comparison in application. Discrete modulation of sinusoidal waveforms: ASK, PSK, FSK. Emission type and documentation (ITU, ALRS). Synthesis of frequency. Radio-wave propagation for VHF, MF, HF bands, long-distance communication, approach to multiple access, modulation techniques, transceivers and antennas. There is an emphasis on radio regulations in international traffic, primarily on the regulations developed by GMDSS, now an integral part of SOLAS. Radiotelephony DSC (Digital Selective Calling in maritime, and (NBDP) radio-telex (FEC, ARQ). For all three forms of communication the operational procedures are described, both for routine and for emergency communications. Required range between ships or ship and coast. Ship positioning in distress (EPIRB, SAR, AIS) as well as the use of these devices when abandoning the ship, ensuring a source of power to them, etc. Cellular radio networks GSM and UMTS. Satellite mobile networks. Basics of satellite channel. Inmarsat network. The role of LES, NCS and OCC. Relation between LES and TK operator (LESO). Traffic characteristics of Inmarsat. Packet switching in maritime affairs. Alternative satellite networks (Iridium, Globalstar, etc.). Broadcasting systems

| **Learning outcomes** |
|---|
| Upon completion of this course students will be able to understand and demonstrate knowledge of communication systems aboard ship. Also they will be able to troubleshoot the different devices and to maintain them at the appropriate technical level. Main goal is to enhance the exploitation and to reduce expenses. They are expected to independently handle different devices and check their good working order. They must be able to detect functional malfunctions and failures, and state equipment to a certain technical level. |

| **TEACHING MODE** | |
|---|---|
| ☒Lectures | ☒Consultations |
| ☐Seminars and workshops | ☐Laboratory |
| ☒Exercises | ☐Field work |
| ☐Independent assignments | ☒Mentoring |
| ☒Multimedia and internet | ☒Exams |
| ☐Distance learning | |

| **EXAMINATION METHOD** | |
|---|---|
| ☐ Oral | Other: |
| ☒ Written | Seminars |
| ☒ Partial exam | |

| **READING** | |
|---|---|
| Compulsory reading | |
| 1. | Krile, S., Electronic Communications in Shipping - Maritime Mobile Networks, Sveučilište u Dubrovniku,2011. |
| 2. | Krile, S., Electronic Communications in Shipping – Mobile Satellite Communications, Sveučilište u Dubrovniku, 2004 |
| 3. | Olsen, J., Kristensen, T., K., An Introduction to GMDSS, Poseidon, 1996. |
| 4. | Dodd A., Telecommunication, Algoritam, Zagreb, 2002. |
| 5. | ITU (UIT), Manual for Use by the Maritime Mobile and Maritime Mobile-Satellite Services, Geneve, 2015/16. |

| Optional reading | |
|---|---|
| 1. | ITU (UIT), Manual for Use by the Maritime Mobile and Maritime Mobile-Satellite Services, Geneve,1.2015/16 |
| 2. | Hydrographer of the Navy, Admiralty List of Radio Signals, Vol. 1 - 6, Taunton, Somerset, 2010/11 |
| 3. | Roddy D., Satellite Communications, McGraw-Hill Professional Publishing, 2001 |

**LIST OF TOPICS**

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |
| 1. | Basics of public and functional TK-networks. Computing networks and Internet. | **4** | **2** | |
| 2. | Transmission: mobile and physical access. Access networks and switching parts. | **4** | **2** | |
| 3. | Frequency distribution plan and channel division. Coverage, propagation characteristics, multiplexing and access. | **4** | **2** | |
| 4. | Analog AM (SSB) | **4** | **2** | |
| 5. | FM modulation and comparison in application. | **4** | **2** | |
| 6. | Discrete modulation of sinusoidal waveforms: ASK, PSK, FSK. | **4** | **2** | |
| 7. | Emission type and documentation (ITU, ALRS). Synthesis of frequency. | **4** | **2** | |
| 8. | Radio regulations in international traffic, primarily on the regulations developed by GMDSS, now an integral part of SOLAS | **4** | **2** | |
| 9. | Radiotelephony on VHF, MF and HF bands. | **4** | **2** | |
| 10. | DSC (Digital Selective Calling) in maritime affairs | **4** | **2** | |

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|---|---|---|---|---|
| 11. | NBDP radio-telex (FEC, ARQ). | **4** | **2** | |
| 12. | AIS, VDR, EPIRB, SART, emergency VHF | **4** | **2** | |
| 13. | Inmarsat system – basics. The role of LES, NCS-a and OCC-a. | **4** | **2** | |
| 14. | Inmarsat-C, Inmarsat Fleet. Packet switching in maritime affairs. LRIT | **4** | **2** | |
| 15. | Iridium, Globalstar, VSAT etc. | **4** | **2** | |
| | **TOTAL HOURS** | **60** | **30** | |

**OTHER RELEVANT INFORMATION**

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**SUMMER SEMESTER – *UNDERGRADUATE / BACHELOR***

| COURSE INFORMATION | |
|---|---|
| **Course name** | **Object oriented programming** |
| **Degree** | Undergraduate |
| **Semester** | Spring |
| **ECTS points** | 6 |
| **Course status** | Compulsory |
| **Course leader** | Krunoslav Žubrinić, PhD, Asst. Prof. |
| Department, room no. | Department of electrical engineering and computing, Ćira Carića 4, D17 |
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| e-mail | krunoslav.zubrinic@unidu.hr |

## COURSE DESCRIPTION

### Course content

Object Oriented Paradigm. Object model and its concepts (abstraction, encapsulation, inheritance, typing). Classes and objects. Variables and methods as class members. Private, protected and public class members. Relationships between classes: association, single and multiple inheritance, use. Polymorphism and virtual functions. Class types (concrete and abstract), interfaces. UML. Basic UML diagrams: use case diagram, class diagram, package diagram, activity diagram, sequence diagram and object diagram. Project specifications. Object oriented modeling. Object oriented programming.

### Learning outcomes

Students will be able to describe basic concepts underlying the object oriented paradigm (abstraction ,encapsulation, polymorphism, classes and objects, as well as the basic elements of classes such as methods, attributes and relationships among classes).Students will be able to document the existing and model new software system using basic UML diagrams (class and sequence diagrams).Student will be able to use the basic object oriented concepts in process of solving specific task. Students will be able to implement the basic object oriented concepts in specific programming language. Student will be able to demonstrate understanding of the systematic approach to the object oriented software development process by designing, building, documenting and presenting a simple software application using object oriented approach and programming language.

| TEACHING MODE | |
|---|---|
| ☒Lectures<br>☐Seminars and workshops<br>☒Exercises<br>☒Independent assignments<br>☒Multimedia and internet<br>☒Distance learning | ☒Consultations<br>☐Laboratory<br>☐Field work<br>☐Mentoring<br>☐Exams |

| EXAMINATION METHOD | |
|---|---|
| ☒ Oral<br>☒ Written<br>☒ Partial exam | Other: |

**READING**

Compulsory reading

| | |
|---|---|
| 1. | Object-Oriented Analysis and Design with Applications, 3rd. edition; G. Booch et. al; Pearson Education;2007; ISBN: 9780201895513 |
| 2. | Fundamentals of Object-Oriented Programming in Java; P. Mohan; CreateSpace IPP; 2013; ISBN:9781482587524 |
| 3. | Object-Oriented Design with UML and Java; K. Barclay & J.Savage; Elsevier / Butterworth- |

Optional reading

2004.; I

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|---|---|
| 1. | Java Tutorial; Oracle Corporation; 2014; online http://docs.oracle.com/javase/tutorial/index.html |
| 2. | Object-Oriented Software Construction, 2nd edition; B. Meyer; Prentice Hall; 1997; ISBN: 0136291554 |
| 3. | Object-Oriented Modelling and Design with UML, 2nd edition; M. R. Blaha and J. R Rumbaugh; Pearson7. Education; 2007; ISBN: 9780130159205 |
| 4. | Python 3 Object Oriented Programming; D. Phillips; Packt Publishing; 2010; ISBN: 9781849511261 |

**LIST OF TOPICS**

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |
| 1. | History of programming. Object oriented paradigm. Introduction to Object oriented programming. Introduction to Java programming language. First Java program. | **4** | **2** | |
| 2. | OOP concepts. Object. Class. Method. Attribute. Java syntax. Variables, data types, operators. Basic program structures: sequence, branching and looping. | **4** | **2** | |
| 3. | OO Model elements: Abstraction, encapsulation, modularity hierarchy. Creating objects in the Java and Python programming languages. Mutator and accessor., | **4** | **2** | |
| 4. | State and behavior of objects. Encapsulation of attributes and methods. Constructor. Use of external libraries. | **4** | **2** | |
| 5. | Links between objects and classes. Association. Specialization. Composition. Aggregation. | **4** | **2** | |
| 6. | Inheritance. The problem of multiple inheritances. Overriding. Variables and class methods. Constants. | **4** | **2** | |
| 7. | Abstract classes and methods. Polymorphism. Java interfaces. Anonymous and inner classes. Java and Python API. | **4** | **2** | |
| 8. | UML. Basic UML diagrams. Object modelling. UML CASE tools. Arrays in Java. Strings. | **4** | **2** | |
| 9. | UML Use Case diagram. Java collections. Java interfaces: Set, List, Queue, Map. | **4** | **2** | |
| 10. | UML Class Diagram. Building Java code based on UML Class Diagram Exceptions. Files.. | **4** | **2** | |
| 11. | UML Package Diagram. Using external packages in Java. Relational databases in Java and Python. | **4** | **2** | |
| 12. | UML Sequence Diagram. Building Java code based on UML Sequence Diagram. GUI. Java *Swing*. Basic GUI widgets. | **4** | **2** | |
| 13. | UML Activity Diagram. Building Java code based on UML Activity Diagram. Layout managers. Complex GUI widgets. | **4** | **2** | |
| 14. | Storing Java objects. Binary files. Unit testing. Threads. Networking | **4** | **2** | |

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| 15. | Source code documentation of OOP program. Javadoc tool. Packaging software | **4** | **2** | |
| | **TOTAL HOURS** | **60** | **30** | |

| **OTHER RELEVANT INFORMATION** |
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| COURSE INFORMATION | |
|---|---|
| **Course name** | Linear algebra |
| **Degree** | Bachelor |
| **Semester** | Spring |
| **ECTS points** | 6 |
| **Course status** | Compulsory |
| **Course leader** | Assistant Professor Ivica Martinjak, PhD |
| Department, room no. | Department of Electrilcal Engineering and Applied Computing |
| Phone | Click here to enter text. |
| e-mail | imartinjak@unidu.hr |
| **Course assistant/associate** | |

| COURSE DESCRIPTION |
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| **Course content** |
| Linear algebra is a branch of mathematics dealing with vectors, matrices and in general with vector spaces and linear operations. The course includes topics in geometry of a system of linear equations, linear operations with vector spaces, determinants and its application, among the other subjects. Linear algebra is very applicable part of math, with implications to many fields including control theory, economy and computer science. |
| **Learning outcomes** |
| 1. To use and to apply matrix calculus<br>2. To solve systems of linear equations<br>3. To use eigenvalues and eigenvectors<br>4. To perform a diagonalization of an operator<br>5. To recognize application of linear algebra in other fields |

| TEACHING MODE | |
|---|---|
| ☒Lectures | ☒Consultations |

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|---|---|
| ☒Seminars and workshops<br>☒Exercises<br>☐Independent assignments<br>☒Multimedia and internet<br>☐Distance learning | ☐Laboratory<br>☐Field work<br>☐Mentoring<br>☐Exams |

| **EXAMINATION METHOD** | |
|---|---|
| ☒ Oral<br>☒ Written<br>☐ Partial exam | Other:<br>Click here to enter text. |

| **READING** | |
|---|---|
| **Compulsory reading** | |
| 1. | Terence Tao, Lecture Notes for Math 115 A – linear algebra |
| 2. | Gilbert Strang, Linear Algebra and Its Application, Thomson Higher Education, USA, 2006. |
| **Optional reading** | |
| 1. | The Princeton Companion to Mathematics, Princeton University Press, 2008 |

**LIST OF TOPICS**

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |
| 1. | Motivation. Linear spaces. Subspaces. Examples | **3** | **3** | |
| 2. | System of linear equations. Linear combination. Geometry of a systems of linear equations | **3** | **3** | |
| 3. | Base and the dimentions of a vector space. Examples of vector bases | **3** | **3** | |
| 4. | Linear transformation of linear spaces. Linear transformation and bases | **3** | **3** | |

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| 5. | Matrix multiplication. Invertible matrices. Gauss-Jordan method. | **3** | **3** | |
| 6. | Determinant of a matrix. Laplace's theorem | **3** | **3** | |
| 7. | Applications of determinants. Cramer rule. Geometric interpretation of the determinant | **3** | **3** | |
| 8. | Diagonalization of a matrix. Eigenvalues and eigenvectors. Applications | **3** | **3** | |
| 9. | Unitary space. Orthogonal vectors. Gram-Schmidt rule | **3** | **3** | |
| 10. | Elements of analitic geometry. Positive-definite matrices | **3** | **3** | |
| | **TOTAL HOURS** | **30** | **30** | |

**OTHER RELEVANT INFORMATION**

Click here to enter text.

| COURSE INFORMATION | |
|---|---|
| **Course name** | **Mobile Application Development** |
| **Degree** | Undergraduate |
| **Semester** | Spring |
| **ECTS points** | 5 |
| **Course status** | Elective |
| **Course leader** | Krunoslav Žubrinić, PhD, Asst. Prof. |
| Department, room no. | Electrical Engineering and Computing Department, Cira Carića 4, D17 |
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| e-mail | krunoslav.zubrinic@unidu.hr |

## COURSE DESCRIPTION

**Course content**

Mobile application development: principles and specifics. Features of mobile technologies: communication protocols, hardware, operating systems and software. Mobile application development standards. Distribution of mobile applications. Development environments and application programming interfaces. Specification of user interface. Modeling, design, building and test of mobile applications. Development of native mobile applications in Android.

**Learning outcomes**

1.Students will be able to describe the features, specificities, and limitations of mobile technologies.
2.Students will be able to describe standards for mobile application development.
3.Student will be able to design mobile app based on collected requests.
4.Student will be able to implement a native mobile app based on a built-in design.
5.Students will be able to demonstrate knowledge of distributing a mobile application over the web.

## TEACHING MODE

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|---|---|
| ☒Lectures | ☒Consultations |
| ☐Seminars and workshops | ☐Laboratory |
| ☒Exercises | ☐Field work |

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|---|---|
| ☒Independent assignments<br>☒Multimedia and internet<br>☐Distance learning | ☐Mentoring<br>☐Exams |

| **EXAMINATION METHOD** | |
|---|---|
| ☒ Oral<br>☒ Written<br>☒ Partial exam | Other: |

**READING**

Compulsory reading

| | |
|---|---|
| 1. | Learning Mobile App Development: A Hands-on Guide to Building Apps with iOS and Android; J. Iversen &M. Eierman; Addison-Wesley; 2014; ISBN: 9780321947864 |
| 2. | Head First Android Development, D. Griffiths & D. Griffiths; O'Reilly; 2015; ISBN:9781449362188 |
| 3. | The Elements of User Experience: User-Centered Design for the Web and Beyond 2nd ed; J. J. Garrett; New Riders; 2011; ISBN: 9780321683687 |
| 4. | Hello, Android: Introducing Google's Mobile Development Platform, 4th ed., E. Burnette; The Pragmatic Programmers, LLC, 2015. ISBN: 9781680500370 |

Optional reading

| | |
|---|---|
| 1. | Mobile Design and Development; B. Fling; O'Reilly; 2009; ISBN: 9780596155445 |
| 2. | Head First Mobile Web; L. D. Gardner and J. Grigsby; O'Reilly; 2012; ISBN: 9781449302665 |
| 3. | Head First iPhone Development; D. Pilone and T. Pilone; O'Reilly; 2010; ISBN: 9780596803544 |
| 4. | Programming Windows Store Apps with HTML, CSS and JavaScript; K. Brockschmidt; Microsoft Press; 2014 ISBN: 9780735672611; online: http://www.microsoftvirtualacademy.com/ebooks |

**LIST OF TOPICS**

| No. | | **Hours** | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |

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|---|---|---|---|---|
| 1. | Mobile devices. Features and categories. Mobile applications. Types. Native, web and hybrid applications. Characteristics of mobile application development. Mobile platforms: Android, iOS, Windows. | 2 | 2 | |
| 2. | Mobile application development. IDE and SDK for developing native Android applications. Programming language Java. | 2 | 2 | |
| 3. | Introduction to Android. Basic elements of Android application: Activities, Intents, Services, Content providers. Elements of Android application: Resources, Application information, and Java code. Android emulator. | 2 | 2 | |
| 4. | GUI for Android applications. Views. Groups. Hierarchy of components. Various layouts: linear, relative, list and grid. | 2 | 2 | |
| 5. | Android application architecture. Application development process: Planning; Sketching the user interface and functionality; Defining the behavior of the application; Writing a program code; Testing. Activities. Graphic components. Events and Actions. Basic building blocks of Android applications. Notifications. | 2 | 2 | |
| 6. | Explicit and implicit intent. Sending parameters by intent. Preview content of picture and web page. Sound reproduction. Sending a message. Fragments. | 2 | 2 | |
| 7. | Data storage. Shared Preferences. Initial and named store. Storing complex data. Serialization and deserialization. JSON. Using Java libraries to work with JSON format. Using the Android shell. | 2 | 2 | |
| 8. | Spinners and pickers. Text spinner. Date picker. Time picker. | 2 | 2 | |
| 9. | Lists. Actions and adapters. Standard adapter. List with non-standard layout. Creating own adapter. | 2 | 2 | |
| 10. | Data storage. Internal and external storage. Files. Access levels. Reading. Writing. Filling a list of data retrieved from the file. | 2 | 2 | |
| 11. | Data storage. SQLite Database. Access to database using the Android shell. Creating and administering a database. Working with data: read, input, modify, delete. | 2 | 2 | |
| 12. | Filling a list of data retrieved from the database. Work with the database by writing SQL statements directly. | 2 | 2 | |
| 13. | Data storage. Network connection. HTTP protocol and methods: GET, POST, PUT, and DELETE. Synchronous and asynchronous processing. | 2 | 2 | |

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| 14. | Web services. RESTful web services. Create, modify and delete data using RESTful network services. | **2** | **2** | |
| 15. | Using mobile device camera and sensors: camera, location and motion sensor. Distribution of Android mobile applications. | **2** | **2** | |
| | **TOTAL HOURS** | **30** | **30** | |

| **OTHER RELEVANT INFORMATION** |
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**WINTER SEMESTER – *GRADUATE / MASTER***

| COURSE INFORMATION | |
|---|---|
| **Course name** | **Process measurements** |
| **Degree** | Graduate |
| **Semester** | Winter |
| **ECTS points** | 5 |
| **Course status** | |
| **Course leader** | Ivana Palunko, PhD, Asst. Prof. |
| Department, room no. | Electrical Engineering and Computing Department |
| Phone | |
| e-mail | ivana.palunko@unidu.hr |

## COURSE DESCRIPTION

**Course content**

This course topic deals with the measurement as part of the manufacturing process. Principles of action and division of sensors and measuring transducers regarding physio-chemical properties and the course of matter and energy; requirements in performance and application. Processing and transmission of measurement signals to the control point, eliminating interference. The basics of intelligent measurements. Visualization of process sizes and overall process. Measurement result analysis and analysis, measurement uncertainty measurement. Application of international regulations and recommendations for quality assurance and supervision. Examples of designing measuring and test equipment in the process automation.

**Learning outcomes**

After successful completion of the course, students will be able to:
1. Explain the division of sensors
2. Explain the Principle of Work – conversion of metric into electrical signals
3. Define the technical features of sensors
4. Identify and suggest the troubleshooting solution

5. Apply international standards for individual sensors6. Select the appropriate sensor for the specific application

## TEACHING MODE

| | |
|---|---|
| ☒Lectures | ☒Consultations |
| ☐Seminars and workshops | ☒Laboratory |
| ☒Exercises | ☐Field work |
| ☒Independent assignments | ☒Mentoring |
| ☒Multimedia and internet | ☒Exams |
| ☐Distance learning | |

## EXAMINATION METHOD

| | |
|---|---|
| ☒ Oral | Other: |
| ☒ Written | In agreement with the course leader there is a possibility of taking part of the exam in the form of a practical project assignment. |
| ☒ Partial exam | |

## READING

Compulsory reading

| | |
|---|---|
| 1. | J. F raden (2010). Handbook of Modern Sensors, Physics, Designs and Applications, Springer-Verlag |
| 2. | Liptak, B. G., editor-inchief (2003). Instrument Engineers Handbook, 4th edition: Process Measurement andAnalysis,CRC Press. |

Optional reading

| | |
|---|---|
| 1. | W. S. Levine: The Control Handbook, IEEE Press, CRC Press, New York, 1996. |

## LIST OF TOPICS

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |

| | | | | |
|---|---|---|---|---|
| 1. | Measurement as part of the manufacturing process. | 2 | 2 | |
| 2. | Principles of action and division of sensors and measuring transducers regarding physio-chemical properties and the flow of matter and energy. Features and requirements in performance and application | 2 | 2 | |
| 3. | Resistive sensing elements for temperature measurement. Feels deformed | 2 | 2 | |
| 4. | Resistive sensing elements for temperature measurement. Feels deformed | 2 | 2 | |
| 5. | Thermoelectric sensing elements (thermocouples) IC sensors | 2 | 2 | |
| 6. | Capacitive sensing elements. Elastic sensing elements. | 2 | 2 | |
| 7. | Inductive sensing elements. Electromagnetic sensing elements | 2 | 2 | |
| 8. | Sensing elements based on Hall principle. Piezoelectric sensing elements. | 2 | 2 | |
| 9. | Sensing elements based on fiber optic technology. Electrochemical sensing elements. | 2 | 2 | |
| 10. | Processing and transmission of measurement signals to the control point, eliminating interference. | 2 | 2 | |
| 11. | The basics of intelligent measurements. | 2 | 2 | |
| 12. | Visualization of process sizes and overall process. | 2 | 2 | |
| 13. | Measurement result analysis, measurement uncertainty measurement. | 2 | 2 | |
| 14. | Application of international regulations and recommendations for quality assurance and supervision | 2 | 2 | |
| 15. | Examples of designing measuring and test equipment in the process automation | 2 | 2 | |

| | | | |
|---|---|---|---|
| **TOTAL HOURS** | **30** | **30** | |
| **OTHER RELEVANT INFORMATION** | | | |
| - | | | |

| COURSE INFORMATION | |
|---|---|
| **Course name** | **Mechatronics** |
| **Degree** | Graduate |
| **Semester** | Winter |
| **ECTS points** | 3 |
| **Course status** | Graduate |
| **Course leader** | Ivana Palunko, PhD, Asst. Prof. |
| Department, room no. | Electrical Engineering and Computing Department |
| Phone | Click here to enter text. |
| e-mail | ivana.palunko@unidu.hr |

## COURSE DESCRIPTION

**Course content**

Kinematics and dynamics of dynamical systems. External forces and stability of dynamical systems; Friction and types of mechatronic systems; Controllability of mechatronic systems; Control of mechatronic systems; Control in normal conditions; Control in extreme conditions.

**Learning outcomes**

After attending the course and passing the exam, the student will acquire basic knowledge in navigation and control of mechatronic systems. With theoretical knowledge, the student will also gain experience in working with real systems during laboratory exercises.

## TEACHING MODE

| | |
|---|---|
| ☒Lectures | ☒Consultations |
| ☐Seminars and workshops | ☒Laboratory |
| ☒Exercises | ☐Field work |
| ☒Independent assignments | ☒Mentoring |

| | |
|---|---|
| ☒Multimedia and internet<br><br>☐Distance learning | ☒Exams |

| **EXAMINATION METHOD** | |
|---|---|
| ☐ Oral<br><br>☒ Written<br><br>☒ Partial exam | Other:<br><br>In agreement with the course leader there is a possibility of taking part of the exam in the form of a practical project assignment. |

| **READING** | |
|---|---|
| Compulsory reading | |
| 1. | R.H. Bishop, “The Mechatronics Handbook”, CRC Press, 2002. |
| 2. | C.W. de Silva, “Mechatronics – an Integrated Approach”, CRC Press, 2004. |
| Optional reading | |
| | |

**LIST OF TOPICS**

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |
| 1. | Introduction to the course, method of exams, office hours, literature | **3** | | |
| 2. | Introduction to mechatronics | **3** | | |
| 3. | Introduction to dynamical systems | **3** | | |
| 4. | Kinematics and dynamics of mechatronic systems | **3** | | |
| 5. | External forces and stability of mechatronic systems | **3** | | |

| | | | | |
|---|---|---|---|---|
| 6. | Sensors in mechatronic systems | **3** | | |
| 7. | Actuators in mechatronic systems | **3** | | |
| 8. | Control of mechatronic systems | **3** | | |
| 9. | Control algorithms for nominal mechatronic systems | **3** | | |
| 10. | Control algorithms in extreme conditions of mechanical systems | **3** | | |
| 11. | Introduction to Pneumatics | | **3** | |
| 12. | Lab 1: Direct and indirect control of one-sided cylinders | | **3** | |
| 13. | Lab 2: Direct and indirect control of two-sided cylinders | | **3** | |
| 14. | Lab 3: Control of cylinder piston speed | | **3** | |
| 15. | Lab 4: Time control and path-dependent control | | **3** | |
| | **TOTAL HOURS** | **30** | **15** | |

**OTHER RELEVANT INFORMATION**

-

| COURSE INFORMATION | |
|---|---|
| **Course name** | **Automatic control of marine systems** |
| **Degree** | Graduate |
| **Semester** | Winter |
| **ECTS points** | 3 |
| **Course status** | Graduate |
| **Course leader** | Ivana Palunko, PhD, Asst. Prof. |
| Department, room no. | Electrical Engineering and Computing Department |
| Phone | Click here to enter text. |
| e-mail | ivana.palunko@unidu.hr |

| COURSE DESCRIPTION |
|---|
| **Course content** |
| Kinematics and dynamics of marine systems. External forces and stability of marine systems; Friction and types of marine systems; Control of marine systems; Control in normal conditions; Control in extreme conditions. |
| **Learning outcomes** |
| After attending the course and passing the exam, the student will acquire basic knowledge in navigation, modeling and control of marine systems. With theoretical knowledge, the student will also gain an experience in working with real systems during laboratory exercises. |

| TEACHING MODE | |
|---|---|
| ☒Lectures | ☒Consultations |
| ☐Seminars and workshops | ☒Laboratory |
| ☒Exercises | ☐Field work |
| ☒Independent assignments | ☒Mentoring |
| ☒Multimedia and internet | ☒Exams |

| | |
|---|---|
| ☐Distance learning | |

| EXAMINATION METHOD | |
|---|---|
| ☐ Oral<br><br>☒ Written<br><br>☒ Partial exam | Other:<br><br>In agreement with the course leader there is a possibility of taking part of the exam in the form of a practical project assignment. |

| READING | |
|---|---|
| Compulsory reading | |
| 1. | T.Fossen - Guidance and Control of Ocean Vehicles, Wiley, 1995. |
| Optional reading | |
| | |

**LIST OF TOPICS**

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |
| 1. | Introduction to the course, method of exams, office hours, literature | **3** | | |
| 2. | Introduction to the automatic control of marine systems | **3** | | |
| 3. | Kinematics and dynamics of marine systems | **3** | | |
| 4. | Dynamics of marine systems – Lagrange model | **3** | | |
| 5. | External forces and stability of marine systems | **3** | | |
| 6. | Resistance and types of marine systems | **3** | | |

| | | | | |
|---|---|---|---|---|
| 7. | Controllability of marine systems | **3** | | |
| 8. | Dynamics and control of marine systems | **3** | | |
| 9. | Control of marine systems under normal conditions | **3** | | |
| 10. | Control of marine systems in extreme conditions | **3** | | |
| 11. | Introduction to Matlab | | **3** | |
| 12. | Lab 1: Kinematics and dynamics of marine systems | | **3** | |
| 13. | Lab 2: External forces and stability of marine systems | | **3** | |
| 14. | Lab 3: Actuator allocation | | **3** | |
| 15. | Lab 4: Control of marine systems | | **3** | |
| | **TOTAL HOURS** | **30** | **15** | |

**OTHER RELEVANT INFORMATION**

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| COURSE INFORMATION | |
|---|---|
| **Course name** | Distributed information systems |
| **Semester** | Winter |
| **ECTS points** | 5 |
| **Course status** | Compulsory |
| **Course leader** | doc. dr. sc. Krunoslav Žubrinić |
| Department, room no. | Department of electrical engineering and computing, Ćira Carića 4, room: D17 |
| Phone | +38520445760 |
| e-mail | krunoslav.zubrinic@unidu.hr |
| **Course assistant/associate** | Ana Kešelj |
| Department, room no. | Department of electrical engineering and computing, Ćira Carića 4, room: D20 |
| Phone | Click here to enter text. |
| e-mail | ana.keselj@unidu.hr |

## COURSE DESCRIPTION

**Course content**

Information system. Network infrastructure and communication. Concept, structure and elements of distributed information systems. Communication between processes. Models: client/server, message communication. Standards, architectures, technologies and Web protocols. Network services. Service-based computing. Web services. Architectural styles of web services: SOA and REST. Development of service-based software. Security of service-based systems. Semantic of web services. Systems with equal participants. Cloud computing.

**Learning outcomes**

After successfully finish the course, students will be able to:

1. Describe the characteristics of distributed information systems.
2. Identify protocols and standards used in distributed information systems.
3. Explain different architectures and procedures for building distributed information systems.
4. Explain the process of building web services.
5. Develop a simple distributed software system based on web services.
6. Assess and evaluate the security and reliability of information systems based on network services.

## TEACHING MODE

| | |
|---|---|
| ☒Lectures<br>☐Seminars and workshops<br>☒Exercises<br>☒Independent assignments<br>☒Multimedia and internet<br>☐Distance learning | ☒Consultations<br>☐Laboratory<br>☐Field work<br>☐Mentoring<br>☐Exams |

**EXAMINATION METHOD**

| | |
|---|---|
| ☒ Oral<br>☒ Written<br>☒ Partial exam | Other:<br>Click here to enter text. |

**READING**

| | |
|---|---|
| Compulsory reading | |
| 1. | T. Erl, Service-Oriented Architecture: Concepts, Technology, and Design, Prentice Hall, 2005. ISBN: 978-0131858589 |
| 2. | RESTful Web APIs: Services for a Changing World; L. Richardson et al; O'Reilly Media, 2013; ISBN: 9781449358068 |
| 3. | G. Coulouris, J. Dollimore, T. Kindberg: Distributed Systems: Concepts and Design, 5rd ed., Addison-Wesley, 2012. ISBN: 0132143011 |
| Optional reading | |
| 1. | R.W.Sebesta, Programming the World Wide Web, 8th ed., Addison Wesley, 2010. ISBN: 9780133775983 |
| 2. | M. Masse, REST API Design Rulebook, O'Reilly Media, 2011; ISBN: 9781449310509 |

**LIST OF TOPICS**

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |
| 1. | Introduction. Distributed information systems. Concept, structure and elements of distributed information systems. Web. A brief historical overview of the development of the | **2** | **2** | |

| | | | | |
|---|---|---|---|---|
| | Web. Standard, architecture and basic web protocols. HTML. CSS. | | | |
| 2. | Processes and communication: client/server, distributed objects, message communication, post-subscription, equivalent participants. | **2** | **2** | |
| 3. | Web technologies for asynchronous real-time communication. AJAX. Semantic markups, microformats, ontology. JavaScript. | **2** | **2** | |
| 4. | Service-based computing. Web services, concept, characteristics, main technologies, division, examples of use. Data formats and protocols. XML. JSON. | **2** | **2** | |
| 5. | Architectural styles. Service and resource oriented architecture. HTTP Protocol basics. HTTP request and response. HTTP message structure. Object model of the HTML document. Use of object model. JavaScript libraries. | **2** | **2** | |
| 6. | REST architectural style. Architecture of the REST system. RESTful web services. | **2** | **2** | |
| 7. | Main HTTP methods: GET, POST, PUT, DELETE. Format of the RESTful messages. Creating a client for using RESTful web services. | **2** | **2** | |
| 8. | RESTful properties and constraints for network and content formatting. Rules and recommendations for creating RESTful web service. Formatting and creating RESTful web services. | **2** | **2** | |
| 9. | Evolution of REST web services. Security restrictions. Synchronous and asynchronous communications. | **2** | **2** | |
| 10. | Technologies for connection in client-server network. Websocket protocol and programming interface. Remote calling of procedures. XML-RPC. | **2** | **2** | |
| 11. | XML Schema. Service oriented architecture. Characteristics of WS-based network services. WS-* set of standards. SOAP. WSDL. | **2** | **2** | |

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|---|---|---|---|---|
| 12. | Rules and recommendations for the development of WS-based network services. WS-* standards. Design and development of web services based on WS-* standards. | **2** | **2** | |
| 13. | Use of web services based on WS-* standards. | **2** | **2** | |
| 14. | Security in service-based systems. Most common security flaws when creating web applications. | **2** | **2** | |
| 15. | Cloud computing. Evolution of cloud computing. Microservices. | **2** | **2** | |
| | **TOTAL HOURS** | **30** | **30** | |
| **OTHER RELEVANT INFORMATION** | | | | |
| Click here to enter text. | | | | |

| COURSE INFORMATION | |
|---|---|
| **Course name** | Mobile and ubiquitous computing |
| **Semester** | Winter |
| **ECTS points** | 5 |
| **Course status** | Elective |
| **Course leader** | doc. dr. sc. Krunoslav Žubrinić |
| Department, room no. | Department of electrical engineering and computing, Ćira Carića 4, room: D17 |
| Phone | +38520445760 |
| e-mail | krunoslav.zubrinic@unidu.hr |
| **Course assistant/associate** | |

**COURSE DESCRIPTION**

**Course content**

Mobile computing. Ubiquitous computing. Pervasive computing. Mobile and vearable computers. Development of mobile applications: principles and characteristics. Characteristics of mobile technologies: communication protocols, hardware support, architecture, operating systems and software. Technologies and standards for the development of mobile applications. Distribution of mobile applications. IDE and API. Specifics of the user interface of mobile and vearable devices. Modelling, design and testing of mobile applications. Development of native mobile applications.

**Learning outcomes**

After successfully finish the course, students will be able to:

- Define and compare the paradigms of mobile and ubiquitous computing.
- Describe the characteristics and limitations of mobile and wearable computers.
- Describe the development standards for mobile applications.
- Describe the design process of application based on mobile technologies and sensors.
- Design a mobile application based on the user specification.
- Implement the native mobile application based on the design.

**TEACHING MODE**

| | |
|---|---|
| ☒Lectures | ☒Consultations |
| ☐Seminars and workshops | ☐Laboratory |
| ☒Exercises | ☐Field work |

| | |
|---|---|
| ☒Independent assignments<br>☒Multimedia and internet<br>☐Distance learning | ☐Mentoring<br>☐Exams |

| **EXAMINATION METHOD** | |
|---|---|
| ☒ Oral<br>☒ Written<br>☒ Partial exam | Other:<br>Click here to enter text. |

| **READING** | |
|---|---|
| Compulsory reading | |
| 1. | J. Krumm (ed.), Ubiquitous Computing Fundamentals, Taylor and Francis Group, LLC, 2010. ISBN: 978-1-4200-9360-5 |
| 2. | D. Griffiths & D. Griffiths, Head First Android Development, O'Reilly, 2015; ISBN: 9781449362188 |
| Optional reading | |
| 1. | G. Roussos (ed.), Ubiquitous and Pervasive Commerce: New Frontiers for Electronic Business, Springer, 2006. ISBN: 978-1-84628-035-1 |
| 2. | J. J. Garrett, The Elements of User Experience: User-Centered Design for the Web and Beyond 2nd ed., New Riders, 2011. ISBN: 9780321683687 |
| 3. | E. Burnette, Hello, Android: Introducing Google's Mobile Development Platform, 4th ed., The Pragmatic Programmers, LLC, 2015. ISBN: 9781680500370 |
| 4. | S. Sullivan, Designing for Wearables: Effective UX for Current and Future Devices, O'Reilly, 2016; ISBN: 9781491944158 |
| 5. | J.P.Vasseur & A.Dunkels, Interconnecting Smart Objects with IP, Elsevier, 2010; ISBN: 9780123751652 |

**LIST OF TOPICS**

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |
| 1. | Introduction. Definitions. Mobile and ubiquitous computing. Pervasive computing. Mobile and wearable computers. Examples. History. Features, types, uses and specificities. | **2** | **2** | |

| | | | | |
|---|---|---|---|---|
| 2. | Features of ubiquitous systems: invisibility, autonomy, adaptability, proactivity, context awareness, mobility, security. Limitations and impact on hardware and software performance. Specificities of microcomputer architectures applicable in ubiquitous systems. | **2** | **2** | |
| 3. | Communication between elements of ubiquitous systems. Data collection, flow and processing. | **2** | **2** | |
| 4. | Features of design, implementation and testing of applications in ubiquitous systems. Interaction with users. Internet of Things. Web Services. HTTP protocol. Main HTTP methods: GET, POST, PUT and DELETE. | **2** | **2** | |
| 5. | Mobile applications. Characteristics and types. Characteristics of mobile applications development. User-centered design. Prototyping. | **2** | **2** | |
| 6. | Mobile platforms. Android. iOS. Other platforms. Introduction to Android. Basic elements of Android application. Activity. Intent. Service. Broadcast receiver. Content Provider. Parts of the Android application: Manifests, resources and code. | **2** | **2** | |
| 7. | Synchronous and asynchronous processing. Asynchronous processing in the mobile application. Connection with web services. Retrieving data from web. Sending data to web. | **2** | **2** | |
| 8. | RESTful web services. Using RESTful web services from mobile devices. | **2** | **2** | |
| 9. | Sensors. Camera. | **2** | **2** | |
| 10. | Geolocation. Location sensor. Mobile motion sensor. | **2** | **2** | |
| 11. | Integrating map into mobile application. Online mapping services. | **2** | **2** | |
| 12. | Speech recognition functionality in the mobile device. | **2** | **2** | |
| 13. | Other mobile device sensors (temperature, light, pressure, acceleration, magnetic field, humidity). | **2** | **2** | |
| 14. | Creating an Android application that uses sensors. | **2** | **2** | |

| | | | | |
|---|---|---|---|---|
| 15. | Mobile application distribution. Mobile application security. | **2** | **2** | |
| | **TOTAL HOURS** | **30** | **30** | |
| **OTHER RELEVANT INFORMATION** | | | | |
| Click here to enter text. | | | | |

*SUMMER SEMESTER GRADUATE/MASTER*

| COURSE INFORMATION | |
|---|---|
| **Course name** | **Autonomous Systems** |
| **Degree** | Graduate |
| **Semester** | Spring |
| **ECTS points** | 4 |
| **Course status** | Graduate |
| **Course leader** | Ivana Palunko, PhD, Asst. Prof. |
| Department, room no. | Electrical Engineering and Computing Department |
| Phone | Click here to enter text. |
| e-mail | ivana.palunko@unidu.hr |

| COURSE DESCRIPTION |
|---|
| **Course content** |
| Autonomous systems modeling: Kinematics and dynamics. Control of autonomous systems: conventional autonomous system control algorithms; Navigation: basic navigational systems, GNSS (Global Navigation Satellite System), navigation based on the terrain, SLAM (simultaneous localization and mapping); Trajectory planning and systems for guidance of autonomous systems. Energy in autonomous systems (conventional and alternative sources); Control of autonomous systems powered by alternative sources; |
| **Learning outcomes** |
| After attending the course and passing the exam, the student will acquire basic knowledge in navigation and control of autonomous systems, basics of alternative energy sources and their control. With theoretical knowledge, the student will also gain experience in working with real systems during laboratory exercises. |

| TEACHING MODE | |
|---|---|
| ☒Lectures | ☒Consultations |
| ☐Seminars and workshops | ☒Laboratory |
| ☒Exercises | ☐Field work |

| | |
|---|---|
| ☒Independent assignments<br>☒Multimedia and internet<br>☐Distance learning | ☒Mentoring<br>☒Exams |

| **EXAMINATION METHOD** | |
|---|---|
| ☒ Oral<br>☒ Written<br>☒ Partial exam | Other:<br>In agreement with the course leader there is a possibility of takingpart of the exam in the form of a practical project assignment. |

| **READING** | |
|---|---|
| Compulsory reading | |
| 1. | R. Siegwart, I. R. Nourbakhs, D. Scaramuzza: Autonomous mobile robots, MIT press, 2011. |
| Optional reading | |
| | |

**LIST OF TOPICS**

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |
| 1. | Introduction to the course, method of exams, office hours, literature | **3** | | |
| 2. | Introduction to autonomous systems | **3** | | |
| 3. | Kinematics and dynamics of autonomous systems | **3** | | |
| 4. | Control of autonomous systems | **3** | | |
| 5. | Conventional control algorithms | **3** | | |

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|---|---|---|---|---|
| 6. | Basics of navigation and navigational systems – GNSS | **3** | | |
| 7. | Terrain-based navigation - SLAM | **3** | | |
| 8. | Path planning for autonomous system navigation | **3** | | |
| 9. | Energy in autonomous systems | **3** | | |
| 10. | Control of autonomous systems with alternative energy sources | **3** | | |
| 11. | Introduction to Arduino and 3D printing | | **3** | |
| 12. | Lab 1: 3D model design | | **3** | |
| 13. | Lab 2: 3D printing of mechanical components | | **3** | |
| 14. | Lab 3: Programming Arduino for control of input and output ports | | **3** | |
| 15. | Lab 4: Control using Arduino | | **3** | |
| | **TOTAL HOURS** | **30** | **15** | |

**OTHER RELEVANT INFORMATION**

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| COURSE INFORMATION | |
|---|---|
| **Course name** | Communication Network Management |
| **Degree** | Master |
| **Semester** | Spring |
| **ECTS points** | 6 |
| **Course status** | |
| **Course leader** | Srećko Compulsory Krile |
| Department, room no. | Electical and computing, D 16 |
| Phone | 385 20 445 739 |
| e-mail | srecko.krile@unidu.hr |

## COURSE DESCRIPTION

**Course content**

The Basics of Communication TK Network Management. Basic Principles of the TMN System. Intelligent network. Separation of control and data levels in new IP networks: MPLS and SDN. Network Configuration and Resource Management. Traffic Routing and Network Balancing Procedures. Protocols and algorithms. IntServ and DiffServ networks. Classification of traffic and achievement of desired quality of service - Quality of Service (QoS). Examples of implementation of routing algorithms in IP networks through MPLS routers. Analysis of the shortcut algorithms in the network, the minimum tree, etc. The basics of traffic engineering (TE) and impact on the new generation network configuration (NGN). VPN Virtualization in an Existing Physical Network. Centralized management in SDN networks via controllers .Elements of hierarchical theory of multi-level systems. Life cycle of the network: dimensioning, installation and maintenance of the network. The basics of waiting and serving theory, load, multiple servers. Management areas. Protocols for Distributed Management in Computer Networks. Basics of SNMP. RMON standard. Use MIBs or dedicated RMON agents, and / or protocol analyzers. Measurement and network performance management: IP packet loss, jitter, ITU-T delay. Guaranteed quality of service. Determining SLS and concluding SLAs. A layered system architecture for distributed ship management and control system (Industrial Bus). Communication network management problems on board.

**Learning outcomes**

Students are expected to understand the principles of communication networks and mastering techniques for their management. Students should be able to independently manage different communication networks, both in public and dedicated TK networks on land as well as on board networks. Above all, they should be able to manage failures and network resources, ie their optimal utilization, with the aim of better exploitation and lower operating costs.They need to be able to analyze the principles of building auxiliary tools, with the aim of creating new solutions for particular traffic situations in the network. They must also adopt certain technologies for the emergence of such auxiliary tools.

## TEACHING MODE

| | |
|---|---|
| ☒Lectures | ☒Consultations |
| ☐Seminars and workshops | ☐Laboratory |
| ☒Exercises | ☒Field work |
| ☒Independent assignments | ☒Mentoring |
| ☒Multimedia and internet | ☒Exams |
| ☐Distance learning | |

## EXAMINATION METHOD

| | |
|---|---|
| ☐ Oral | Other: |
| ☒ Written | |
| ☒ Partial exam | |

## READING

Compulsory reading


| | |
|---|---|
| 1. | Krile S., Komunikacijski sustavi u pomorstvu - Mobilne radiomreže, Sveučilište uDubrovniku, 2011. |
| 2. | Tanenbaum, Computer Networks, Prentice-Hall, 2002. |
| 3. | Maršić, I., Computer Networks, Perfomance and Quality of Service, Rudgers University, New Jersey, 2013. |
| 4. | Bažant, A., Kos, M, Lovrek, I. & all, Osnovne arhitekture mreža, Sveučilište u Zagrebu, Zagreb, 2003. |

| | |
|---|---|
| 5. | Sinković, V., Informacijske mreže, Školska knjiga, Zagreb, 1994. |
| Optional reading | |
| 1. | Dodd A., Telekomunikacije, Algoritam, Zagreb, 2002. |
| 2. | http://www.dpstele.com/layers/l2/snmp_l2_tut_part1.php |
| 3. | http://web.studenti.math.pmf.unizg.hr/~manger/mr/MrezeRacunala-24.pdf |
| 4. | http://www.cert.hr/sites/default/files/NCERT-PUBDOC-2010-09-313.pdf |
| 5. | R.G.L. Fundamentals of TMN, IEEE Press, 1999. |

**LIST OF TOPICS**

| No. | | Hours | | |
|---|---|---|---|---|
| | | **L** | **E** | **S** |
| 1. | The basics of communication network management. Users and networks. Data flow communication and control segment. Safe transmission and possible congestion. Intelligent network. | **2** | **2** | |
| 2. | The basics of waiting and serving theory, load, multiple servers. | **2** | **2** | |
| 3. | Relationship of traffic capacities on lines and routers. The principles of forwarding traffic. Skimping and explicit routing. Alternative traffic routes. | **2** | **2** | |
| 4. | Dimensioning the transmission system, installing and maintaining the network. Network analysis, sensitivity and robustness. Balancing traffic. | **2** | **2** | |
| 5. | Traffic Routing Procedures via Routing Tables. Protocols and algorithms. Solving Congestion Traffic Problems in Practical Examples. | **2** | **2** | |
| 6. | Examples of implementation of routing algorithms in IP networks. Analysis of algorithms for searching the shortest path, minimum tree and maximum flow. OSPF | **2** | **2** | |
| 7. | ntServ and DiffServ networks. Mpls. Classification of traffic and achievement of desired quality of service - Quality of Service (QoS). | **2** | **2** | |

| | | | | |
|---|---|---|---|---|
| 8. | The Basics of Traffic Engineering (TE) and Influence on New Generation Network Configuration. | **2** | **2** | |
| 9. | QBR routing. Network Interconnection, QoS in Mobile Networks. | **2** | **2** | |
| 10. | CSPF-TE, Virtualization Network (VPN). | **2** | **2** | |
| 11. | SDN network options. The role of the controller in OpenFlow. | **2** | **2** | |
| 12. | TK-Network Control Protocols. Basic Principles of TMN Systems.Architecture of distributed management and control systems. | **2** | **2** | |
| 13. | SNMP Monitoring System Architecture. SNMP message format. RMON standard. Use MIBs or dedicated RMON agents. | **2** | **2** | |
| 14. | Communication system for data collection. Communication networks and interfaces to operators in distributed management systems. | **2** | **2** | |
| 15. | Layered hierarchical architecture of surveillance and management. RT real time communication. Master-slave and peer-to-peer communication. | **2** | **2** | |
| | **TOTAL HOURS** | **30** | **30** | |

## OTHER RELEVANT INFORMATION

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