

OBDELAVA IN VREDNOTENJE PODATKOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Obdelava in vrednotenje podatkov
Course title:	Data processing and validation
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - razvojno raziskovalni program, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0577609
Koda učne enote na članici/UL Member course code:	2033-U

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30		30			40	4

Nosilec predmeta/Lecturer:	Edvard Govekar
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Izvajalci predavanj:	
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course	Obvezni splošni predmet /Compulsory general course
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type:

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Jeziki/Languages:

Predavanja/Lectures:	Slovenščina
Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Izpolnjevanje pogojev za vpis v Univerzitetni študijski program I. stopnje Strojništvo - Razvojno raziskovalni program.	Meeting the enrollment conditions for the Academic study programme of Mechanical Engineering - Research and Development program.
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Vsebina:

Content (Syllabus outline):

<p>1. Predavanje: Uvod in osnovni pojmi verjetnostnega računa</p> <ul style="list-style-type: none">- Opredelitev poizkusa, izida in dogodka- Relacije med dogodki- Pojem in definicije verjetnosti dogodka- Verjetnost unije, preseka dogodkov- Pogojna verjetnost in odvisnost dogodka- Več nivojski poskus in Bayessova formula <p>2. Predavanje: Naključne spremenljivke</p> <ul style="list-style-type: none">- Opredelitev diskretne in zvezne naključne spremenljivke in verjetnosti- Oblike porazdelitvega zakona verjetnosti (kumulativna porazdelitev verjetnosti, funkcija verjetnosti in gostote verjetnosti)- Lastnosti porazdelitvenega zakona in osnovni parametri (srednja vrednost, varianca), neenačba Čebiševa <p>3. Predavanje: Primeri porazdelitev verjetnosti</p> <ul style="list-style-type: none">- Binomska porazdelitev- Hipergeomtrična- Poissonova- Eksponenta- Gaussova <p>4. Predavanje: Vektorske naključne spremenljivke</p> <ul style="list-style-type: none">- Definicija vektorske naključne spremenljivke	<p>1. Lecture: Introduction and basic concepts of probability calculus</p> <ul style="list-style-type: none">- Definition of a trial, outcome and event- Relations between events- The concept and definitions of the probability of an event- Probability of events union and product- Conditional probability and dependence of events- Multi-level experiment and Bayes formula <p>2. Lecture: Random variables</p> <ul style="list-style-type: none">- Definition of a discrete and continuous random variable and probability- Forms of the probability distribution law (cumulative probability distribution, probability mass function and probability density)- Properties of the distribution laws and basic parameters (mean, variance), Chebyshev inequality <p>3. Lecture: Selected examples of probability distributions</p> <ul style="list-style-type: none">- Binomial- Hypergeometric- Poisson's- Exponential- Gaussian <p>4. Lecture: Vector random variables</p> <ul style="list-style-type: none">- Definition of a vector random
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<ul style="list-style-type: none"> - Opre delitev povezane in robne gostote verjetnosti - Gostota pogojne verjetnosti - Kovarianca in korelacija <p>5. Predavanje: Funkcije naključnih spremenljivk</p> <ul style="list-style-type: none"> - Splošna opredelitev - Kvadratična funkcija in hi-kvadrat porazdelitev - Porazdelitev linearne kombinacije spremenljivk in konvolucijski integral <p>6. Statistična povprečja in momenti</p> <ul style="list-style-type: none"> - Definicija statističnega povpečja diskretne, zvezne in funkcije naključne spremenljivke - Lastnosti statističnega povprečja - Statistični moment in centralni momenti - Povezani momenti in centralni momenti - Primeri pomembnih statističnih povprečij <p>7. Osnovni pojmi statistike</p> <ul style="list-style-type: none"> - Populacija, naključni vzorec - Vzorčne karakteristike in osnovne statistike - Točkovne cenilke (vzorčno povprečje in varianca, vzorčni momenti, relativna frekvenca in histogram) <p>8. Metode določanja točkovnih cenilk</p> <ul style="list-style-type: none"> - Metoda momentov - Metoda maksimalnega verjetja <p>9. Verjetnostne porazdelitve statistik</p> <ul style="list-style-type: none"> - Porazdelitev vzorčnega povprečja in centralni limitni teorem - Hi-kvadrat porazdelitev vzorčne variance - Z-statistika in Gaussova porazdelitev - T - statistika in Studentova porazdelitev - F - statistika in Snedecorjeva porazdelitev <p>10. Intervalna ocena parametrov</p> <ul style="list-style-type: none"> - Koncept in interpretacija intervalne ocene - Enostranska in dvostanska intervalna ocena - Intervalne ocene srednje vrednosti – Z in T statistika - Intervalna ocena variance – Hi kvadrat statistika 	<p>variable</p> <ul style="list-style-type: none"> - Definition of joined and boundary probability density - Conditional probability density - Covariance and correlation <p>5. Lecture: Functions of random variables</p> <ul style="list-style-type: none"> - General definition - Quadratic function and chi-square distribution - Distribution of a linear combination of variables and convolution integral <p>6. Lecture: Statistical means and moments</p> <ul style="list-style-type: none"> - Definition of the statistical mean of a discrete, continuous, and function of random variable - Statistical mean properties - Statistical moment and central moments - Joined moments and central moments - Examples of important statistical means <p>7. Lecture: Basic concepts of statistics</p> <ul style="list-style-type: none"> - Population, random sample - Sample characteristics and basic statistics - Point estimators (sample mean and variance, sample moments, relative frequency and histogram) <p>8. Lecture: Methods for determining point estimators</p> <ul style="list-style-type: none"> - Method of moments - Method of maximal likelihood <p>9. Lecture: Probability distributions of statistics</p> <ul style="list-style-type: none"> - Distribution of sample mean and central limit theorem - Chi-square distribution of sample variance - Z-statistic and Gaussian distribution - T-statistic and Student distribution - F-statistic and Snedecor distribution <p>10. Lecture: Interval estimation of parameters</p> <ul style="list-style-type: none"> - Concept and interpretation of interval estimation - One-sided and two-sided interval estimation
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<ul style="list-style-type: none"> - Vpliv in izbira velikosti vzorca na odklon cenilke <p>11. Statistične hipoteze I</p> <ul style="list-style-type: none"> - Osnovni pojmi in koncept testa - Enostanski in dvostranski test - Napake pri testu, njihovo ovrednotenje in interpretacija - p vrednost testa <p>12. Statistične hipoteze II</p> <ul style="list-style-type: none"> - Test parametričnih hipotez (Z in T test srednje vrednosti, F test variance) - Prilagoditveni neparametrični hi kvadrat test - Test neodvisnosti in homogenosti spremenljivk - Test enakosti dveh normalnih populacij in zaznavanje vpliva dvonivojskega faktorja - Praktični primer v Matlab okolju <p>13. Test ANOVA- analiza variance in zaznavanje vpliva večnivojskega faktorja</p> <ul style="list-style-type: none"> - Osnovni pojmi in koncept testa - Opredelitev hipoteze, F statistike in potek in interpretacija testa - Praktični primeri ANOVA v Matlab okolju <p>14. Empirično modeliranje in cenilke funkcij</p> <ul style="list-style-type: none"> - Osnovni pojmi in koncept parametričnih in neparametričnih cenilk funkcij - Parametrična linearna regresija - Neparametrična regresija in cenilka pogojnega povprečja - Praktični primeri v Matlab okolju <p>15. Naključni procesi</p> <ul style="list-style-type: none"> - Osnovni pojmi, definicija in praktični primeri - Razvrstitev in lastnosti procesov - Osnove opisa naključnih lastnosti (statistična poprečja po ansamblu, avtokovariančna funkcija) - Pojem stacionarnosti in preverjanje stacionarnosti naključnega procesa - Osnove karakterizacije - Amplitudna porazdelitev in statistični momenti, Avtokorelacijska funkcija, Spektralna gostota - Praktični primeri karakterizacije procesov v Matlab okolju 	<ul style="list-style-type: none"> - Interval estimation of mean - Z and T statistics - Interval estimation of variance - chi square statistic - Influence and choice of sample size on estimator deviation <p>11. Lecture: Statistical Hypotheses I</p> <ul style="list-style-type: none"> - Basic concepts and concept of the test - One-sided and two-sided test - Test errors, their evaluation and interpretation - p value of the test <p>12. Lecture: Statistical Hypotheses II</p> <ul style="list-style-type: none"> - Test of parametric hypotheses (Z and T test of mean, F test of variance) - Goodness-of-fit non-parametric chi-square test - Variables independence and homogeneity test - Test of equality of two normal populations and two-level factor influence detection - Practical example in Matlab environment <p>13. Lecture: ANOVA test - analysis of variance and detection of multilevel factor influence</p> <ul style="list-style-type: none"> - Basic concepts and concept of the test - Definition of hypothesis, F-statistics, test implementation and interpretation - Practical ANOVA examples in Matlab environment <p>14. Lecture: Empirical modelling and function estimators</p> <ul style="list-style-type: none"> - Basic concepts, concept of parametric and non-parametric function estimators - Parametric linear regression - Non-parametric regression and conditional mean estimator - Practical examples in Matlab environment <p>15. Lecture: Random processes</p> <ul style="list-style-type: none"> - Basic concepts, definition and practical examples - Classification and properties of processes
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	<ul style="list-style-type: none"> - Basics of random properties description (ensemble statistical means, auto-covariance function) - The concept of stationarity, verification of stationarity of a random process - Characterization basics - Amplitude distribution and statistical moments, Autocorrelation function, Spectral density - Practical examples of process characterization in Matlab environment
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Temeljna literatura in viri/Readings:

1. Edvard GOVEKAR, *Naključni pojavi : elektronski zapiski in interaktivni učbenik*. Univerza v Ljubljani, Fakulteta za strojništvo, 2005.
<http://lab.fs.uni-lj.si/lasin/www/teaching/np/predavanja.htm>. [COBISS.SI-ID [11321371](#)]
2. Igor GRABEC, Janez GRADIŠEK, *Opis naključnih pojavov*, 2000, Univerza v Ljubljani, Fakulteta za strojništvo. [COBISS.SI-ID [276189696](#)]
3. Douglas C. MONTGOMERY, George C. RUNGER, *Applied statistic and probability for engineers*, Third edition, 2003, John Wiley and Sons.
[COBISS.SI-ID [16830747](#)]
4. Julius S. BENDAT, Allan G. PIERSOL , *Random Data: Analysis and measurement procedures*, 4th ed., 2010, John Wiley and Sons.[COBISS.SI-ID [13038875](#)]

Cilji in kompetence:

Cilji:

1. Spoznati osnove uporabe verjetnosti in izbranih porazdelitev verjetnosti pri opisu naključnih lastnosti pojavov v strojništvu
2. Spoznati metode statistike in statističnega sklepanja pri interpretaciji merskih podatkov in reševanju tehničnih problemov v strojništvu
3. Spoznati osnove obdelave in karakterizacije naključnih procesov

Kompetence:

1. P1-RRP: Obvladovanje temeljnih znanj verjetnosti in statistike, ki so potrebna za obvladovanje tehničnega področja strojništva
2. S6-RRP: Sposobnost za uporabo verjetnosti in statističnih metod pri samostojnem reševanju tehničnih

Objectives and competences:

Objectives:

1. To learn the basics of application of probability and selected probability distributions in describing random properties of phenomena in mechanical engineering
2. To learn methods of statistics and statistical inference in interpretation of measurement data and solving technical problems in mechanical engineering
3. To learn the basics of processing and characterization of random processes

Competences:

1. P1-RRP: Mastery of basic skills of probability and statistics, fundamental to the technical aspect of mechanical engineering
2. S6-RRP: The ability to use the methods of probability and statistics

problemov v strojništvu 3. P4-RRP: Sposobnost osnovnega statističnega modeliranja z razvito sposobnostjo kritične analize rezultatov	to solve professional engineering problems independently 3. P4-RRP: The ability of basic statistical modelling with the ability of critically analysing the results
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Predvideni študijski rezultati:	Intended learning outcomes:
<p>Znanja:</p> <p>Z1: Poglobljeno strokovno teoretično in praktično znanje na področju uporabe verjetnosti in statističnih metod pri vrednotenju in interpretaciji inženirskih podatkov.</p> <p>Spretnosti:</p> <p>S1.1 Izvajanje kompleksnih operativno-strokovnih opravil, temelječih na analizi in vrednotenju inženirskih podatkov, ki vključujejo tudi uporabo metodoloških orodij.</p> <p>S1.3 Diagnosticiranje in reševanje različnih problemov v različnih specifičnih delovnih okoljih.</p>	<p>Knowledge:</p> <p>Z1: Thorough professional theoretical and practical knowledge in the field of applied probability and statistical methods for evaluation and interpretation of engineering data.</p> <p>Skills:</p> <p>S1.1 Executing complex operational-professional tasks based on analysis and evaluation of engineering data, including usage of methodological tools.</p> <p>S1.3 Problem diagnostics and solving in different and specific working environments.</p>

Metode poučevanja in učenja:	Learning and teaching methods:
<p>P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov.</p> <p>P3 Avditorne vaje, kjer se teoretično znanje s predavanj podkrepi z računskimi primeri.</p> <p>P5 Uporaba študijskega gradiva v obliki e-zapiskov.</p> <p>P6 Interaktivna predavanja.</p> <p>P8 Izdelava in predstavitev aplikativnih seminarskih nalog.</p> <p>P14 Virtualni eksperimenti.</p>	<p>P1 Auditorial lectures with solving selected field-specific theoretical and applied use cases.</p> <p>P3 Auditorial exercises, in which theoretical content from the lectures is supplemented with computational examples.</p> <p>P5 Application of study material in form of e-notes.</p> <p>P6 Interactive lectures.</p> <p>P8 Making and presenting applied seminar exercises.</p> <p>P14 Virtual experiments.</p>

Načini ocenjevanja:	Delež/ Weight	Assessment:
Teoretične vsebine (predavanja).	50,00 %	Theoretical content (lectures).
Tačunski primeri iz avditornih.	50,00 %	Auditory Computer Cases.

Ocenjevalna lestvica:

Grading system:

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Reference nosilca/Lecturer's references:

Edvard Govekar:

1. POTOČNIK, Primož, ŠKERL, Primož, **GOVEKAR, Edvard**. Machine-learning-based multi-step heat demand forecasting in a district heating system. *Energy and buildings*. [Print ed.]. Feb. 2021, vol. 233, str. 1-14, ilustr. [COBISS.SI-ID [45195779](#)]
2. POTOČNIK, Primož, **GOVEKAR, Edvard**. Semi-supervised vibration-based classification and condition monitoring of compressors. *Mechanical systems and signal processing : MSSP*, Sep. 2017, vol. 93, str. 51-65. [COBISS.SI-ID [15296539](#)]
3. JEROMEN, Andrej, **GOVEKAR, Edvard**. Time series analysis based study of a mass-spring-like oscillation and detachment of a metal pendant droplet. *Mechanical systems and signal processing : MSSP*, Dec. 2016, vol. 80, str. 503-516, ilustr. [COBISS.SI-ID [14623515](#)]
4. THALER, Tilen, KRESE, Blaž, **GOVEKAR, Edvard**. Stability diagrams and chatter avoidance in horizontal band sawing. *CIRP annals*. 2015, vol. 64, iss. 1, str. 81-84, [COBISS.SI-ID [13966107](#)],
5. POTOČNIK, Primož, SOLDÓ, Božidar, ŠIMUNOVIĆ, Goran, ŠARIĆ, Tomislav, JEROMEN, Andrej, **GOVEKAR, Edvard**. Comparison of static and adaptive models for short-term residential natural gas forecasting in Croatia. *Applied energy*, ISSN 0306-2619, Sep. 2014, vol. 129, str. 94-103, ilustr. [COBISS.SI-ID [13478939](#)]