Short list of courses for exchange between Universidad Nacional de Colombia and Universität Kassel

Last change made by: MRT / Uni-Kassel, 09.12.2019

Courses from UNAL for guest students from Uni-KS suitable for acknowledgment at Uni-KS

Note: UNAL responsible: PRI (International Affairs Program – Faculty of Engineering)

Note: Acknowledgment of achievements accomplished by lecturers at Kassel University

Note: Contents of courses from Table 1 can be found in Table 2

Table 1 (Gray shaded courses currently not available):

Nr.	Course	Lecturer UNAL	Hours/ Week UNAL	CP		ID/Cod. UNAL	Specialization* Uni-KS	Person responsible Uni-KS
				UNAL	Uni-KS			
1	Tecnicas de control *Control techniques* Für Regelungstechnik: Zustandsraummethoden und Mehrgrößensysteme (Sommer)	J. Sofrony	4	3	4	2022888	A	Prof. Kroll
2	Técnicas de inteligencia artificial *Artificial intelligence techniques* Komplementär (Kroll). CIA darf nicht belegt werden.	F. Prieto	4	4	6	2017290	A	Prof. Kroll
3	Vision de máquinas *Machine vision* Komplementär (Kroll)	F. Prieto	4	4	6	2019170	A	Prof. Kroll
4	Control de robots *Robot control* Komplementär (Kroll)	J. Sofrony	4	4	6		A	Prof. Kroll

5	Robotica *Robotics* Komplementär (Kroll)	P. Cardenas	4	3	4	2027321	A	Prof. Kroll
6	Sistemas no lineales *Non-linear systems* Für nichtlineare Regelungssysteme (Linnemann) Für Nichtlineare Schwingungen (Hetzler)	E. Mojica	4	4	6	2019147	A M	Prof. Linnemann Prof. Hetzler
7	Control digital avanzado *Advanced digital control* Komplementär (Kroll)	G. Ramos	4	4	6		A	Prof. Kroll
8	Microcontroladores *Microcontrollers* Komplementär (Börcsök)	P. Cardenas	4	4	6	2016753	A	Prof. Börcsök
9	Diseno de sistemas embebidos *Embedded system design* Für Mikroprozesstechnik und eingebettete Systeme 1 (Börcsök)	C. Camargo	4	3	4	2016508	A	Prof. Börcsök
10	Instalaciones HVAC *HVAC installations* Für Technische Anwendungen der Kälte- und Wärmepumpentechnik (Luke)	J. Mahecha	4	3	4	2023287	E	Prof. Luke
11	Combustion *Combustion* Komplementär (Luke)	M. Mantilla	4	4	6	2023656	E	Prof. Luke
12	Dinamica de fluidos computacional *Computational fluid dynamics* Für Numerische Berechnung von Strömungen (Wünsch)	C. Duque	4	4	6	2026605	M	Prof. Wünsch
13	Tratamientos termicos *Heat treatment* Komplementär (Niendorf)	I. Angarita	4	4	6	2023121	W P	Prof. Niendorf Prof. Böhm
14	Procesamiento digital de imagines *Digital image processing* Komplementär (Kroll)	E. Romero	4	4	6	2026480	A	Prof. Kroll
15	Mecanica de fluidos *Fluid mechanics* Für Strömungsmechanik (Wünsch)		4	4	6	2015966	M	Prof. Wünsch

*) Abbreviations:

B.Sc. / M.Sc. Mechanical engineering

- M: Angewandte Mechanik
- A: Automatisierung und Systemdynamik
- E: Energietechnik / Energie- u. Prozesstechnik
- P: Produktionstechnik u. Arbeitswissenschaft
- W: Werkstoffe und Konstruktion

B.Sc. / M.Sc. Mechatronics engineering

- EI: Elektrotechnik / Informatik
- MB: Maschinenbau
- KfM: Kraftfahrzeugmechatronik
- OS: Optoelektronische Systeme
- SM: Smart mechatronic systems

Contents of suitable courses from UNAL

Table 2:

Nr.	Course contents	Nr.	Course contents
1	**Control techniques** **Contents** • Mathematical Preliminaries o Introduction to multivariable control o Performance limitations o Stability according to Lyapunov o Linearization of nonlinear systems • Introduction to Robust Control o Generalized Nyquist o Generalized regulator plant o Multi objective optimization and mixed sensitivity problem o Application to a flight control system • Introduction to nonlinear control o ON-OFF control o Introduction to absolute stability (Passivity and judgment of the circle) o SMC - Sliding Mode Control o Explicit parameter estimation in adaptive control o Application to a flight control system • Extensions of classical techniques o Winding effect and Anti-windup strategies • Nonlinear systems: Gain Scheduling and Switched Systems	**2**	**Artificial intelligence techniques** **Contents** • Digital Image Processing Basic concepts. Acquisition of images. Sampling and Quantization. Basic relations between pixels. Histograms. Image operations. Color. Filters in the spatial domain. Smoothing and highlighting filters. Morphological Process of Images. Dilation and Erosion. Opening and closing. Transform Hit-or-Miss. Basic Algorithms. Extension to gray images. Segmentation. Contour-based techniques. Thresholding techniques. Region based techniques and Mixed media. • Pattern Recognition Generalities. Discriminating functions. Selection and extraction of characteristics. Performance evaluation. Euclidean Classifier. Representation of images (segments). Features based on contour. Characteristics based on regions. Supervised learning. Bayesian Classifier. Method of the nearest k-neighbors. Non - supervised learning. Chained distances. Max-Min Algorithm. K –Means Algorithm. ISODATA algorithm. • Neural Networks Introduction. Perceptron. Linear networks. Nonlinear Networks. Multilayer feed-forward networks. Supervised learning in ANN (back propagation). Kohonen Maps. Competitive learning. Hopfield Networks. RNA with radial basis functions.

3	**Machine vision** **Contents** • Introduction. • Image enhancement: image transforms. • Restore images. • Color in Images: Models and Operations. Morphological Process of Images. Image Segmentation. Representation and Description of Images. Movement in Images. • Geometry and camera parameters - Stereo vision. • Selection and Extraction of Characteristics. Recognition of Patterns. Density Estimation, Parametric and Non-Parametric Methods. Linear and Non-Linear Discriminant Analysis. Non-Supervised Methods (clustering). Evaluation and Improvement of the classifiers.	**4**	**Robot control** **Contents** • Introduction to rigid body motion • Forward and inverse kinematics • Mobile Robots • Euler-Lagrange systems • Independent Joint Control: PID and feed forward control • Multivariable Control: Inverse dynamic control, Adaptive control and variable gain • Path Planning: Rapid random trees and artificial potential fields

5	**Robotics**
	
	Contents
	• History of robotics
	  o Basic definitions
	  o Robot taxonomy
	  o Robotics in the global context
	• Robot morphology
	  o Components of robots
	  o Sensors and actuators
	• Mathematical tools for serial manipulators
	  o Position and orientation
	  o Euler angles
	  o Homogeneous coordinates
	  o Homogeneous transformations
	• Geometric modeling of serial manipulators
	  o Generalized Coordinates
	  o Serial robots
	  o Denavith-Hartemberg parameters
	  o Joint modeling
	  o Direct geometric model
	  o Inverse geometric model
	  o Analysis and solution of inverse geometric problem
	• Kinematic modeling of manipulators
	  o Introduction to the differential model
	  o The Jacobian and its representations
	  o Singularities
	  o Force and static Jacobian
	• Kinematic Control
	  o Introduction
	  o Third order interpolator
	  o Trapezoidal Interpolator
	• Introduction to dynamics of serial manipulators
	  o ABB Robots.
	  o Introduction to Robot studio
	• Introduction to RAPID
		6	**Non-linear systems**
			
			Contents
			• Unit I: Introduction to the nonlinear phenomenon
			Nonlinear models, typology of nonlinear phenomena, examples.
			• Unit II: Second order systems and fundamental properties.
			Phase plane, classification of equilibrium points, behavior of second order systems, limit cycles and the existence of periodic orbits (Poincaré-Bendixon Theorem), bifurcation, Existence and Oneness.
			• Unit III: Analysis of stability
			Lyapunov stability of autonomous systems, the principle of invariance (Theorem LaSalle), linear systems and linearization, , input-to-State Stability, early Passivity.
			• Unit IV: Introduction to nonlinear control
			Linearization through state feedback, I / O linearization and full state

7	**Advanced digital control** **Contents** • Introduction. Structures for the implementation of digital control systems. • Discrete systems and signals. Discrete signals. Equations of difference. Z-Transformation. Transfer functions. Frequency response. Causality. Systems with delays. Dynamics of discrete systems. Stability. • Digital implementation of continuous controllers. Discretization. FOH, ZOH, Euler and Tustin. Poles and zeros. Selection of the sampling period. • Classic design techniques. Root-Locus. Design by pole location: permissible regions for Poles placement using Root-Locus: proportional controller, PD and PI. Designs based on frequency response. Diagrams of Bode and Nyquist. Design with Bode diagrams. PI Controllers. • Algebraic design techniques. I/O Design. Design of the transfer function. Quadratic indices and ITAE. Configuration with Unit feedback. Diophantus equations, pole location. Robustness and Rejection of disturbances. Drivers of two degrees of freedom owned by sturdiness. • Design in state space. Equations of state. Discretization. Stability. Controllability and Observability. Canonical forms. Status feedback. State estimators. Monitoring of the reference signal and the principle of internal model. Estimation of disturbances. • Advanced digital control. Techniques based on the principle of the internal model: Control based on resonators and repetitive control. Active rejection of Disturbances. LQR systems and Kalman filter.	**8**	**Digital control techniques** **Contents** • Introduction. Structures for the implementation of digital control systems. • Discrete systems and signals. Discrete signals. Equations of difference. Z-Transformation. Transfer functions. Frequency response. Causality. Systems with delays. Dynamics of discrete systems. Stability. • Digital implementation of continuous controllers. Discretization. FOH, ZOH, Euler and Tustin. Poles and zeros. Selection of the sampling period. • Classic design techniques. Root-Locus. Design by pole location: permissible regions for Poles placement using Root-Locus: proportional controller, PD and PI. Designs based on frequency response. Diagrams of Bode and Nyquist. Design with Bode diagrams. PI Controllers. • Algebraic design techniques. I/O Design. Design of the transfer function. Quadratic indices and ITAE. Configuration with Unit feedback. Diophantus equations, pole location. Robustness and Rejection of disturbances. Drivers of two degrees of freedom owned by sturdiness. • Design in state space. Equations of state. Discretization. Stability. Controllability and Observability. Canonical forms. Status feedback. State estimators. Monitoring of the reference signal and the principle of internal model. Estimation of disturbances. • Advanced digital control. Techniques based on the principle of the internal model: Control based on resonators and repetitive control. Active rejection of Disturbances. LQR systems and Kalman filter.

8	**Microcontrollers** Study of the NXP S08 Family, architecture, ports of entry and exit, specific modules, programming languages, development tools and general frameworks, that allow the student to make specific applications in the solution of problems. **General description** 1. Reset and interruptions 2. Setup 3. CGMC 4. Input and output (I / O) ports 5. Analog-to-digital converter (ADC) 6. KBI module 7. External Interruptions (IRQ) 8. Timebase module (TBM) **Contents** • First week. General description of a microprocessor, internal architecture and peripherals • Second week: Families of microcontrollers, Memory Map Structure I / O ports, Oscillator time instructions, testing and programming the system. • Third week: Memory and memory maps. Specific Function registers and general purpose registers. Addressing Modes • Fourth week: Programming techniques, instruction set, editing, debugging, compiling and simulation. • Fifth week: Types of instructions, jumps and conditions (for, while, if, major, minor, etc.). • Sixth week: Performance evaluation • Seventh week: I/O Ports, mode setup, programing and lab work. • Eighth week: I/O Ports, mode setup, programing and lab work. • Ninth week: Oscillator, delays, control registers, timer and time delay mode programing and lab work. • Tenth week: Types of IRQs, register configurations; external event interruptions, programing and lab work. • Eleventh week: Types of IRQs, register configurations; external event interruptions, programing and lab work. • Twelfth week: Setup and use of the ADC. Analog-to-digital converter; Serial (UART) communication. Lab work • Thirteenth week: Applications and development of final project. • Fourteenth week: Applications and Development of final project. • Fifteenth week: Applications and development of final project.	**9**	**Embedded systems design** **Contents** • Embedded Systems o Definition and applications o Design methodologies o Architecture o The Silicone System o Reference Circuits • Introduction and Setup o Boot methods and Boot loaders • Embedded LINUX OS o Architecture o Synchronization between processes o Structure and organization of the kernel and source code structure o Device Drivers and kernel modules o Kernel Image o Kernel initialization • Root File System o Types of File System o Root File System Structure o Configuration files and levels of execution. o Assembly of root file system • Interface with external devices o Signal control using general purpose Input / Output (GPIOs) headers o Using UART, I2C, SPI, USB communications ports. o Using the SoC External Memory Controller • Dedicated peripheral implemented in PLDs o Configuration of the PLD using GPIOs SoC o Definition of the HW and SW Interface o Communication with dedicated peripherals

10	**HVAC installations** **Contents** • Fields of application of refrigeration • Operating principles - The refrigeration cycle by compression of Steam • Compression refrigeration of Steam – basic components • Accessories in the refrigeration cycle • Evaluation of the thermal load • Refrigerants • Different applications of cooling systems • Refrigeration by absorption • Other cooling systems • Installation or maintenance	**11**	**Combustion** **Contents** • **Introduction, combustion and thermal chemistry,** definition, applications of combustion, modes of combustion, types of flame sources, relationship between properties, first law, mixtures of reactants and products, adiabatic flame temperatures • **Chemical balance,** Second Law, Gibbs function, complex systems, combustion products in balance, overall balance, water-gas equilibrium, effects of pressure, applications • **Chemical Kinetics,** INTRODUCTION, global counter elementary reactions, elementary reactions rates, bimolecular reactions to unimolecular reactions mechanism, chain reactions, partial equilibrium. • **Chemical and thermal coupling in reactive systems,** reactor pressure for constant and fixed mass, constant volume reactor and fixed mass, Well-Stirred reactor, plug-flow reactor. Application to combustion systems • **Fuel oxidation mechanisms,** Introduction, the H2-O2 system, CO oxidation, oxidation of large-scale paraffin, methane combustion, formation of hydrogen peroxide or Nitroglycerin. • **Transport phenomenon,** Introduction, concepts of mass transfer, mass transfer laws, conservation of species, some applications • **Equations of conservation**, Introduction, conservation of mass, conservation of species, dissemination of multicomponent and subtopics, conservation of time and subtopics, conservation of energy and subtopics, the concept of preserved climbing and Subtopics • **Non-premixed Laminar flames,** Introduction, Jet nonreactive and sub-structure flames and subtopics, flame length for different burners and subtopics, formation of MP, counterflow flames and subtopics. • **Emissions, I**ntroduction, effects of pollutants, quantification of emissions and subtopics, emissions for premixed combustion and sub-combustion emissions of non-premixed and subtopics. • **Combustion in turbulent flows**, Introduction, definition, time and length scales, analysis of turbulent flows, jet igniter axis • **Combustion in turbulent flows,** Introduction, applications and sub-turbulent flame speed, structure and sub-regimes: laminar folded, distributed flamelets, flame stabilization and subtopics. • **Combustion in turbulent flows:** jet flames and subtopics. • **Detonations,** Introduction, description and subtopics, analysis of the 1D case, detonation speeds, structure of detonation waves.

12	**Computational fluid dynamics** **Contents** • **Introduction, flow models, reviews:** Definitions, explanations, examples, simulation vs. experiment, fluid characteristics, process an analysis, CFD Software available. Notation, tensor quantities in fluid mechanics, vectors • **Dynamics fluid equations:** Description of fluid flow models and frames reference, deduction of equations, constitutive relations, initial and boundary conditions, dimensionless form, simplified flow models. PDE: Types, spatial discretization techniques, computational grids. • **Finite difference method:** approximation first or second order, mixed derivatives, higher order approximations, error analysis, treatment of complex geometry • **Finite volumes method:** definition for volume control rules quadrature Newton-Cotes, techniques of interpolation, UDS, CDS, QUICK, assessment and surface integrals, discretization of transport problems, examples. • **Solution of systems of linear equations:** direct and Iterative, coupled equations, nonlinear equations. Convergence criterion and iteration errors • **Techniques to advance in time:** unstable flows, discretization or n-space, method of Galerkin schemes two levels, fully discretized problem, properties, fractional step theta scheme, method predictor-corrector and multipoint, m and all of Adams, m and all Runge-Kutta, Control to the passage of time, implementation, stability, examples • **Solution of the Navier Stokes equation:** General, character, special characteristics, array variables in the mesh, calculation of pressure, methods of solution, incompressible and pressure, boundary conditions, Examples • **Compressible flow** **Turbulent flow:** General, DNS, LES, RANS, Reynolds Stress Models, discretization or implementation.	**13**	**Heat treatments** **Contents** • **Introduction:** Fundamentals in thermal treatment, Terminology • **Classification of steel:** Principles, limiting carbon steels, effects of alloying elements on diagrams balance, effects of alloying elements on the phases present in steels • **Transformation patterns and continuous isothermal cooling:** Main features and differences between the diagrams, TT diagram types for analysis of the microstructure. • **Combined heat treatment** • **Softening heat treatment:** recrystallization, stress relieving, annealing phase. Isothermal recovery, standardized. balling, industrial applications, thermal cycling and properties of methods • **Tempering:** Foundations, microstructure process, and process variable product (shape), features, defects, applications and new technologies • **Tempering in mild steel** Foundations, process variables mechanical properties behavior. Process variables, secondary hardening. Double revenge • **Hardening:** Terminology and fundamentals, cooling curves, handling and applications, Jomminy curves. • **Stainless steel:** Fundamentals, ferritic properties, applications • **Surface heat treatment:** Foundations, hardfacing by flame and induction materials, equipment, features and applications, steel materials, equipment, features and applications.

14	**Digital image processing** **Contents** • Preliminary – photometry, Neurofisiology, Psico-physic • Introduction - Processing - Color Spaces - Sampling and quantification • Processing: Representations base - Images and stochastic processes: the histogram as processing tool - Geometric transformations: coordinate transformation and interpolation - Data Structures for images • Information Theory: Probability and entropy -The theorem of variance in the codification – theory of estimation • Filters: Edge detectors, linear detectors. Prewitt and Sobel. Canny. Second order and nonlinear filters – Statistical filters	**15**	**Fluid Mechanics** **Contents** • **Properties of fluids:** Systems units, transformation units, equation dimensionally homogeneous line and no line, definition of pressure or shear. Shooting basics properties of fluids. Classification of fluids, equation of state of gases and process • **Fluids at rest:** Measuring ranges for pressure, fundamental fluid equation , incompressible fluid and compressible fluid, pressure gauges, forces generated by fluids at rest: flat and curved surfaces, Flotation • **Fluid motion:** Fundamental properties of fluids in motion: velocity, acceleration, rotation, volume, mass, energy, momentum. Classification of flows. • **Flow measurements:** general equation of flow in streams, pressure and coefficients (and its variation): Venturi tube, orifice in tube, Pitot tube, orifice tanks: constant load and Variable load.

Courses from Uni-KS for guest students from UNAL suitable for acknowledgment at UNAL

Note: Uni-KS responsible: see Table 3

Note: Acknowledgment of achievements accomplished by the International Affairs Program (PRI UNAL) – Faculty of Engineering

Note: Contents of courses from Table 3 can be found in Table 4

Table 3 (Gray shaded courses currently not available):

Nr.	Course	Lecturer Uni-KS	Hours/Week Uni-KS	CP		ID/Cod. Uni-KS	Specialization* Uni-KS	Person responsible Uni-KS
				UNAL	Uni-KS			
1	Grundlagen und numerische Anwendungen der Bruchmechanik *Fundamentals and numerical applications of fracture mechanics*	Prof. Ricoeur	4	TBD	6	121016	M E W	Prof. Wünsch Prof. Luke Prof. Niendorf
2	Systemidentifikation *System identification*	Prof. Kroll	4	TBD	6	112027	A SM	Prof. Kroll Prof. Sick / Prof. Linnemann
3	Data mining für technische Anwendungen *Data mining for technical application*	Prof. Sick	4	TBD	6	104001	A MB EI	Prof. Kroll Prof. Fister / Prof. Lehmann Prof. Lehmann / Prof. Fister
4	Computational Intelligence in der Automatisierung *Computational intelligence in automation*	Prof. Kroll	4	TBD	6	112008	A MB EI SM	Prof. Kroll Prof. Fister / Prof. Lehmann Prof. Lehmann / Prof. Fister Prof. Sick / Prof. Linnemann
5	Sensoren und Messsysteme *Sensors and measurement systems*	Prof. Lehmann	4	TBD	6	109014	A MB EI KfM OS	Prof. Kroll Prof. Fister /Prof. Lehmann Prof. Lehmann / Prof. Fister Prof. Fister / Prof. Spieker Prof. Lehmann
6	Angewandte Regelungstechnik in der Fahrzeugmechatronik *Applied Control Engineering for Vehicle Mechatronics*	Prof. Fister	4	TBD	6	114012	MB EI KfM	Prof. Fister / Prof. Lehmann Prof. Lehmann / Prof. Fister Prof. Fister / Prof. Spieker
7	Grundlagen Antriebsaggregate im Kraftfahrzeug	Prof. Fister	4	TBD	6	114013	W MB	Prof. Niendorf Prof. Fister / Prof. Lehmann Prof. Lehmann / Prof. Fister

	Principles of power trains in automobiles						EI M KfM	Prof. Wünsch Prof. Fister / Prof. Spieker
8	Elektrische und elektronische Systeme im Automobil I *Automotive electrical and electronic systems 1*	Prof. Brabetz	2	TBD	3	107011	MB EI KfM	Prof. Fister / Prof. Lehmann Prof. Lehmann / Prof. Fister Prof. Fister / Prof. Spieker
9	Elektrische und elektronische Systeme im Automobil II *Automotive electrical and electronic systems 2*	Prof. Brabetz	2	TBD	3	107012	KfM	Prof. Fister / Prof. Spieker
10	Auszüge aus der Analytischen Strömungsmechanik *Excerpt of Theoretical Fluid Mechanics*	Prof. Wünsch	2	TBD	3	124020	M E	Prof. Wünsch Prof. Luke
11	Maschinen- und Rotordynamik *Machine Dynamics and Rotor Dynamics*	Prof. Hetzler	4	TBD	6	122002	M A MB A	Prof. Wünsch Prof. Kroll Prof. Fister / Prof. Lehmann Prof. Kroll
12	Festigkeit und Versagen von Konstruktionswerkstoffen *Strength and Failure of Structural Materials*	Prof. Niendorf	4	TBD	6	151002	M W E	Prof. Wünsch Prof. Niendorf Prof. Luke
13	Nichtlineare Schwingungen *Nonlinear Oscillations*	Prof. Hetzler	4	TBD	6	125003	M A	Prof. Wünsch Prof. Kroll
14	Simulationsmethoden für Windkraftanlagen *Methods for simulation of wind turbines*	Prof. Kuhl	2	TBD	3	120410	M E	Prof. Ricoeur Prof. Luke
15	Autonome Mobile Roboter *Autonomous mobile robots*	Prof. Geihs	4	TBD	6	124005	A M OS SM	Prof. Kroll Prof. Wünsch Prof. Lehmann Prof. Sick / Prof. Linnemann
16	Einführung in die Mehrkörperdynamik *Introduction to multibody dynamics*	Prof. Hetzler	4	TBD	6	125002	M A	Prof. Wünsch Prof. Kroll
17	Strukturcharakterisierung von biobasierten Polymerwerkstoffen *Structure characterization of bio-based polymer materials*	Prof. Heim	2	TBD	3	153005	W	Prof. Niendorf

18	Optimierungsverfahren *Optimization methods*	Prof. Stursberg	4	TBD	6	117016	A SM	Prof. Kroll Prof. Sick / Prof. Linnemann
19	Energiemonitoringsystem *Energy Monitoring Systems*	Prof. Hesselbach	2	TBD	3	132022	E P	Prof. Luke Prof. Wenzel
20	Energiemonitoring in der Praxis *Measurement of material and energy flows (Practical work)*	Prof. Hesselbach	2	TBD	3	132023	E P	Prof. Luke Prof. Wenzel
21	Knowledge Discovery *Knowledge Discovery*	Prof. Stumme	4	TBD	6	125003	R GM	Prof. Lehmann Prof. Fister
22	Nanosensorik und –aktuatorik *Nanosensors and nanoactuators*	Prof. Hillmer	4	TBD	6	109007	OS	Prof. Lehmann
23	Temporal and Spatial Data Mining *Temporal and Spatial Data Mining*	Prof. Sick	4	TBD	6	104010	A OS SM	Prof. Kroll Prof. Lehmann Prof. Sick / Prof. Linnemann
24	Such- und Optimierungsverfahren für die Automatisierung *Search and optimization methods for automation*	Dr. Sommer	2	TBD	3	112023	A SM	Prof. Kroll Prof. Sick / Prof. Linnemann
25	Fahrzeugtechnik: Aktuelle Kompeonenten und Systeme *Vehicle techniques: Current components and systems*	Prof. Brabetz	2	TBD	4	107017	W KfM	Prof. Niendorf Prof. Fister / Prof. Spieker
26	Analoge und digitale Messtechnik *Analog and digital measurements*	Prof. Lehmann	4	TBD	6	109002	OS	Prof. Lehmann
27	Microsystem technology *Microsystem technology*	Prof. Hillmer	2	TBD	3	119010	OS	Prof. Lehmann
28	Ausgewählte Themen zur Digitalen Produktions- und Logistikplanung *Selected topics on digital production and logistics planing*	Prof. Wenzel	2	TBD	3	134011	P	Prof. Wenzel
29	Soft computing *Soft computing*	Prof. Sick	4	TBD	6	104002	MB EI SM	Prof. Fister / Prof. Lehmann Prof. Lehmann / Prof. Fister Prof. Sick / Prof. Linnemann
30	Computational mechanics *Computational mechanics*	Prof. Matzenmiller	4	TBD	6	123006	M W	Prof. Wünsch Prof. Niendorf

31	Energieeffiziente Produktion Grundlagen *Energy efficient production basics*	Prof. Hesselbach	2	TBD	3	132016	E P	Prof. Luke Prof. Wenzel
32	Energieeffiziente Produktion Vertiefung *Energy efficient production specialisation*	Prof. Hesselbach	2	TBD	3	132017	E P	Prof. Luke Prof. Wenzel
33	Additive Fertigung *Additive manufacturing*	Prof. Niendorf	2	TBD	3	151012	P W	Prof. Wenzel Prof. Niendorf
34	Technische Anwendung der Kälte- und Wärmepumpentechnik *Technical Application of Refrigeration and Heat Pump Technology*	Prof. Luke	2	TBD	3	141012	E	Prof. Luke
35	Technische Anwendung der Kälte- und Wärmepumpentechnik – Praktikum *Technical Application of Refrigeration and Heat Pump Technology (Practical work)*	Prof. Luke	2	TBD	3	141015	E	Prof. Luke
36	Grundlagen der Bereitstellung und energetischen Nutzung von Biomasse *Principles of preparation and energetic use of biomass*	Prof. Wachendorf	2	TBD	3	143102	E	Prof. Luke

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- P: Produktionstechnik u. Arbeitswissenschaft
- W: Werkstoffe und Konstruktion

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- EI: Elektrotechnik / Informatik
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- KfM: Kraftfahrzeugmechatronik
- OS: Optoelektronische Systeme
- SM: Smart mechatronic systems

Contents of suitable courses from Uni-KS

Table 4:

Nr.	Course contents	Nr.	Course contents
1	**Fundamentals and numerical applications of fracture mechanics** • Linear- elastic fracture mechanics, K-Concept • Methods of energy release rates • Methods of weight functions • Cohesive zone models • Theory of material forces and J-Integrals • Numerical techniques for load analysis with FEM	**2**	**System identification** • Introduction and overview into model building • Linear and nonlinear model sets • Estimation of static and dynamic models • Identification of nonparametric and parametric models • Identifiability, information, designs of test signals and experiments • Evaluation criteria, validation and confidence • Selection of model structure, identification and control loop • Estimation of local affine multi-models • Practical case studies, computational tools
3	**Data Mining for technical applications** • Fundamentals and pre-processing of data • Selection of features • Linear classifiers (perceptron, linear compensation problems, Fisher criteria) • Nonlinear classifiers (Support Vector Machines, RBF networks, generative classifiers, Relevance Vector Machines) • Bayesian networks • Ensemble methods	**5**	**Sensors and measurement systems** • Principles of sensors and construction • Electromechanic principles • Electroacoustic principles • Optoelectric principles • Electronic temperature measurement • Electrochemical principles • Sensor modeling • Optical and acoustic measurement principles wit applications • Principles of geometrical optic • Optics, image processing systems • Principles and applications of electromagnetic and acoustic waves • Principles and applications of coherence • Fiber sensors

6	**Applied control for vehicle mechatronics** • Components of a real and digital control loop • Modeling of a vehicle drivetrain • Practical implementation of a controller for damping of vibration in the vehicle drivetrain	**4**	**Computational Intelligence in automation** • What is computational intelligence and what are their main characteristics • Problem definition and solving methods • Pattern recognition and classification • Modeling • Control • Optimization and search • Fuzzy logic and fuzzy systems • Fuzzy clustering • Fuzzy modeling and fuzzy identification • Fuzzy control • Application examples • Artificial neural networks • General aspects • MLP, RBF and SOM networks • Application examples • Evolutionary algorithms • General aspects • Genetic algorithms • Evolution strategies • genetic programming • Application examples • Hybrid CI systems • Swarm intelligence and artificial immune systems
7	**Principles of power trains in automobiles** • Working principle of the four cycle piston engine • Crank mechanism • Cycles, gas pressure, torque • Load control • Filling of cylinders, mixing processes • Combustion process • Emissions, treatment of exhaust gases • Motor management: Sensors, actuators, control loops		
8	**Automotive electrical and electronic systems I** • Product development process of autos • Project management • On-board networks and electrical energy supply in auto • Vehicle electrics: actuators, lights, safety, switching, bus systems • Electronic systems: Drivetrain, alternative drivers		

9	**Automotive electrical and electronic systems II** • Vehicle dynamics (ABS, ESP, steering, damping) • Passenger protection • Man-Machine interfaces • Assistance systems • Bus systems 2 • Diagnosis and risk assessment • Tools for mechatronic systems development: CASE/CAx, validation, architecture, future trends	**10**	**Excerpt of theoretical fluid mechanics** • Classic flow problems • Simplification of the Navier-Stokes-equations • Discussions of basic solution characteristics • Preparation and solution of classic initial boundary value problems
11	**Machine dynamics and rotor dynamics** • Introduction and motivation • Isolation of vibrations • Piston machines • Drivetrains: Typical construction forms, torsion bar, etc. • Rotor dynamics • Balancing • Moving continua	**12**	**Strength and failure of structural materials** • Overview of most important failure phenomena • Elasticity theory • Internal stresses • Material resistance magnitudes • Relevant load cases • Relationship between strength and microstructure • Treatment of stress concentration free, notched, cracked, and with internal stresses components • Introduction to fracture mechanics
13	**Nonlinear oscillations** • Introduction • Background: Dynamic systems, state space, solutions • Stability for solutions • Approximation methods: Harm. Balance (Galerkin), multiple time scales, mean values • Phenomena: nonlinear resonance, self-excitation, parameter excitation • Branches and solution tracing	**14**	**Methods for simulation of wind turbines** • Energy transformation in wind turbines • Component of wind turbines • Introduction to the environmental fluid mechanics • Simulation methods of the surround-flow in rotor blades • Simulation methods for analysis of swell loads • Simulations methods for towers and rotor blades • Duration analysis for components in a wind turbines • Aerodynamics of rotor blades • Correlation between fluid and structure for rotor blades

15	**Autonomous mobile robots** • Hardware • Sensors • Actuators • World modeling • Communication and middle ware • Behavior control	**16**	**Introduction to multibody dynamics** • Introduction, motivation • Kinematics: Notation (vectors/matrices), coordinate systems, derivation of vectors wrt. kinematic systems, general movements of rigid bodies • Kinematic principles: Impulse, principle of angular momentum, principle of linear momentum for rigid bodies, inertia tensor, kinetic energy of rigid bodies • Rigid body systems: Kinematics, degrees of freedom, Lagrange equations, etc. • Numerics: Principles of numerics for ODE- systems and DAE systems • d' Alember-Lagrange, Jourdain and Gauss principles • Kinematics and dynamics of elastic multibodies
17	**Structure characterization of bio-based polymer materials** • Overview of the most relevant bio-based polymers: natural polymers, bio-based plastics • Introduction to the solid structure of polymers • Molecular structure • Crystal structure • Supramolecular structure • Growth architecture • Method for characterization of structures • Overview • NMR-Spectroscopy • Electron microscopy • Practical example	**18**	**Optimization methods** • Introduction to the optimization of mathematical functions • Lineal optimization • Duality in convex optimization • Quadratic optimization • Nonlinear unconstrained optimization • Nonlinear programming and additional constrains • Mixed-integer optimization • Optimization of dynamic systems • Application examples
19	**Energy monitoring systems** • Principles of measurement technique • Temperature measurement / Thermography • Pressure measurement • Flow measurement • Concentration measurement • Application examples	**20**	**Measurement of materials and energy flows – Practical work** • Exercises regarding measurement principles • Exercises regarding: o Temperature measurement o Thermography o Flow measurement o Concentration measurement

21	**Knowledge discovery** • Knowledge extraction from structured data and texts • Pre-processing and integration of data sets, data warehouse • OLAP techniques • Machine learning techniques	**22**	**Nanosensors and nanoactuators** • Microscopic imaging and processing techniques • Confocal microscopy • Interferometry • Digital holography and holographic microscope • Optical sensors • Glass fiber sensors • Thin layer productions and characterization • Absorption spectroscopy and gas sensors • Intra cavity absorption spectroscopy • Photoluminescence • Bio and chemo sensors • GMR sensors
23	**Temporal and spatial data mining** • Basic principles • Distance measurement of time series • Clustering/classification • Motive recognition • Recognition of anomalies • Application examples	**24**	**Search and optimization methods** • Data structure and computational implementation • Basic principles of searching and algorithms: • Basic concepts • Dijktras algorithm • Monte Carlo methods • Grover algorithm for quantum computers • Fuzzy searching • SAT-solution algorithms • Basic principles of optimization and algorithms • Basic concepts • Goal function • Optimization under additional constrains • Multi-goal optimization • Pontryagin's maximum principle • Bellman's optimization principle • Special algorithms • Applications
25	***Vehicle techniques: Current components and systems*** • Architecture of on-board networks and effects of accessories • Construction of electrical machines in autos and controller • Electrical machine requirements for high tensions • Hybrid drivetrains • Power converters in autos • Optimization of combustion motors • Service concept in autos		

27	**Microsystem technology** • Introduction with examples: expressions in micromachining, why miniaturization of optoelectronic devices? Why integration of micromachined components? Overview of applications of microsystem technology (MEMS, MOEMS), Scaling of basic forces, vision of a micro world • Basics of the technological realization of microstructures, materials in micromachining, technological processes • Fluid-coolers, mechanical valves, membranes, springs resonator elements, cantilevers, cantilever arrays for frequency sensoring Alignment components in optoelectronics (main principles, applications: e.g. single detectors, detector arrays, chemo sensors, bio sensors, signal processing • Actuators and their application (main principles, classifications, examples: manipulation elements for optical components, gripping tools, light modulators, filters, switches, beam splitters, displays, (LEDs, semiconductor lasers), frequency modulation of different components, maximum modulation frequencies • Microsystem Technology (MEMS and MOEMS), components with external optical resonators, e.g. LEDs, filters, lasers with external mirrors, projection displays (DMD, laser TV), system technology, micro optical bench, free beam optics, data distribution • Sensors (chemosensors, biosensors and others) Perspectives in micromachining and microsystem techniques.	**26**	**Analogue and digital measurements** • Analogue measurements • Analogue systems • Measurement amplifier • Analogue filters • AD-Converter • DA-converter • Interfaces • Digital measurements • Analogue and digital signals • Time domain, frequency domain (Fourier-transformation) • Sampling and reconstruction • DFT • Spectral analysis • Correlation analysis • Time-Frequency analysis • Laplace and Z-transformation • Hilbert transformation • Stochastic signals • Digital filtering • Digital image processing
28	**Selected topics on digital production and logistic planning** • Production and logistic planning • Digital planning methods • Digital fabric	**29**	**Soft computing** • Biological basic principles • Monitored self-learning neuronal networks • Unmonitored self-learning neuronal networks • Learning methods of first order • fuzzy logic and fuzzy systems, genetic algorithms and evolutionary methods • Applications

30	**Computational mechanics** • Continuum mechanics principles • Kinematics • Balance equations for mass, impulse and angular impulse • Virtual shift principle • Linear elasticity • Shift equations • Level problems • Nonlinear elasticity • Material models in the hyperelasticity theory • Incompressible behavior of rubbery materials • Compressible behavior for elastomers • Introduction to FEAPpv (Software) • Linear viscoelasticity • Nonlinear FEM-problems • Deformation of structures	**32**	**Efficient energy production specialization** • Principles of energy • Energy requirements of selected machines and processes • Influence of production planning on the energy consumption • Correlation between technical building services and production processes • Measures for increasing energy efficiency during production • Implementation of renewable energies in the production
		33	**Additive manufacturing** • Methods of additive manufacturing • Possibilities of the additive manufacturing • Configuration guidelines • Mechanical and micro structural characteristics of additively manufactured structures • Application examples
31	**Efficient energy production basics** • Calculation of energy flows • Balancing of energy flows in machines, plant and production buildings • Finding of carbon foot prints in machines and production plants • Energy efficiency potential in innovative technologies • Compressed air • Illumination • Co-generation of heat and power • Heating and steam engineering • Refrigeration engineering • Thermal insulation • Air-conditioning engineering • Energy efficiency potential in selected production technologies • Economical evaluation of energy efficiency measures	**34**	**Technical application of refrigeration and heat pump technology** • Multi-level installations • Components of compression and absorption cool/heat machines • Methods for power regulation in cool/heat machines • Application of heat pumps in house automation and industry Cryogenics

35	**Technical application of refrigeration and heat pump technology – Practical work** Laboratory testing and analysis of the results	**36**	**Principles of preparations and energetic use of biomass** • Biomass preparation • Principles of energetic use of biomass • Combustion • Methods • Features of: o Solid fuels o Thermo-chemical gasification o Bio gas / methane o Ethanol o Bio diesel o Rapeseed oil