UNIVERSITY IN SARAJEVO
FACULTY OF ELECTRICAL ENGINEERING
SARAJEVO

THREE-YEAR BACHELOR STUDY
AT
FACULTY OF ELECTRICAL ENGINEERING
(Programme: Automatic Control and Electronics)

Programme: ACE, PE, CI, TC

Year First year

Semester First semester

	Courses						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Mathematics for Engineers 1	ETF IM1 I-1175	7,0	75	49	0	26
2.	Fundamentals of Electrical Engineering	ETF OE I-1180	7,0	80	48	4	28
3.	Physics for Engineers 1	ETF IF1 I-1160	5,0	60	39	0	21
4.	Linear Algebra and Geometry	ETF LA I-1160	5,0	60	39	0	21
5.	Fundamentals of Computing	ETF OR I-1170	6,0	70	44	26	0
		TOTAL:	**30,0**	**345**	**219**	**30**	**96**

Programme: ACE, PE, CI, TC

Year First year

Semester Second semester

	Courses						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Mathematics for Engineers 2	ETF IM2 I-1280	7,0	80	52	0	28
2.	Electrical Circuits 1	ETF EK1 I-1275	7,0	75	45	10	20
3.	Physics for Engineers 2	ETF IF2 I-1260	5,0	60	39	0	21
4.	Programming Techniques	ETF TP I-1270	6,0	70	44	26	0
5.	Electronic Elements and Circuits	ETF EES I-1260	5,0	60	39	0	21
		TOTAL:	**30,0**	**345**	**219**	**36**	**90**

Legend:

H/S - Hours per semester
P - Lectures per semester
L - Laboratory exercises
T - Tutorials

Programme: Automatic Control and Electronics

Year Second year

Semester Third semester

	Courses						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Mathematics for Engineers 3	ETF AEO IM3 I-2380	5,0	70	42	0	28
2.	Electrical Circuits 2	ETF AEO EK2 I-2365	6,0	65	42	0	23
3.	Electrical Measurement	ETF AEO EM I-2360	5,0	60	35	20	5
4.	Analogue Electronics	ETF AEO AE I-2360	5,0	60	36	24	0
5.	Sensors and Measurements	ETF AEO SM I-2360	5,0	60	36	18	6
6.	**Elective course 1**		4,0	55			
		TOTAL:	**30**	**370**			

	Elective course 1						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Dynamical Systems	ETF AEI DS I-2355	4,0	55	35	10	10
2.	Discrete Mathematics	ETF AEI DM I-2360	5,0	60	39	0	21

Legend:

H/S - Hours per semester
P - Lectures per semester
L - Laboratory exercises
T - Tutorials

Programme: Automatic Control and Electronics

Year Second year

Semester Fourth semester

	Courses						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Digital Electronics	ETF AEO DE I-2460	5,0	65	39	16	10
2.	Modeling and Simulation	ETF AEO MS I-2460	5,0	60	39	21	0
3.	Linear Automatic Control Systems	ETF AEO LS I-2460	5,0	60	36	8	16
4.	**Elective course 2**		5,0	60			
5.	**Elective course 3**		5,0	60			
6.	**Elective course 4**		5,0	60			
		TOTAL:	**30,0**	**365**			

	Elective course 2						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Lab Work in Electrical Engineering and Electronics	ETF AEI PEE I-2460	5,0	60	11	39	10
2.	Lab Work in Automatics and Informatics	ETF AEI PAI I-2460	5,0	60	11	39	10

	Elective course 3						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Electrical Machines	ETF AEI EM I-2470	5,0	70	39	16	15
2.	Actuators	ETF AEI AK I-2460	5,0	60	39	16	5
3.	Fundamentals of Database Systems	ETF AEI OBP I-2460	5,0	60	40	20	0

	Elective course 4						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Telecommunication Basics	ETF AEI OT I-2456	5,0	60	42	0	14
2.	Fundamentals of Optoelectronics	ETF AEI OO I-2450	5,0	50	36	7	7

Legend:

H/S - Hours per semester
P - Lectures per semester
L - Laboratory exercises
T - Tutorials

Programme: Automatic Control and Electronics

Year Third year

Semester Fifth semester

	Courses						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Digital Integrated Circuits	ETF AEO DIK I-3560	5,0	60	36	24	0
2.	Digital Control Systems	ETF AEO DSU I-3560	5,0	60	36	8	16
3.	Signals and Systems	ETF AEO SS I-3560	5,0	60	36	8	16
4.	Logical Systems Design	ETF AEO PLS I-3560	5,0	60	42	18	0
5.	**Elective course 5**		5,0	60			
6.	**Elective course 6**		5,0	60			
		TOTAL:		**660**			

	Elective course 5						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Lab Work in Automatic Control	ETF AEI PA I-3545	5,0	60	15	36	9
2.	Lab Work in Electronics	ETF AEI PE I-3560	5,0	60	15	36	9

	Elective course 6						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Operating Systems	ETF AEI OS I-3560	5,0	60	38	22	0
2.	Software Development	ETF AEI RPR I-3560	5,0	60	38	22	0
3	Elective from other faculty		5,0	55			

Legend:

H/S - Hours per semester
P - Lectures per semester
L - Laboratory exercises
T - Tutorials

Programme: Automatic Control and Electronics

Year Third year

Semester Sixth semester

	Courses						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Structures and Operational Modes of Electrical Power Systems	ETF AEO SES I-3660	5,0	60	33	18	9
2.	Mechatronics	ETF AEO ME I-3660	5,0	60	42	18	0
3.	**Elective course 7.1**		4,0	60			
4.	**Elective course 7.2**		4,0	60			
5.	Final Thesis	ETF AEO ZR I-36110	12,0	110			
		TOTAL:	**30,0**	**350**			

	Elective course 7.1, 7.2						
N	**Title**	**Code**	**ECTS**	**H/S**	**P**	**L**	**T**
1.	Robotics 1	ETF AEI RO I-3660	4.0	60	39	11	10
2.	Fluid Dynamics and Thermal Systems	ETF AEI DF I-2460	4.0	60	42	0	18
3.	Power Electronics	ETF AEI EE I-3660	4.0	60	39	11	10
4.	Design of Microprocessor Based Systems	ETF AEI PMS I-3660	4.0	60	33	24	3

Legend:

H/S - Hours per semester
P - Lectures per semester
L - Laboratory exercises
T - Tutorials

Module description

Module title	Mathematics for Engineers 1	
Module code	ETF IM1 I-1175	
Programme	ETF-B PE, ACE, TC, CI	
Module coordinator	Dr Huse Fatkić, Associate Professor	
Teaching staff	Dr Huse Fatkić, Associate Professor Alvin Abdagić, MoE, Teaching Assistant Mehmed Brkić, MoE, Teaching Assistant	
Year of study	1	
Semester	1	
Module type	Mandatory	
ECTS	7	
Lectures	49	
Laboratory exercises	0	
Tutorials	26	
Workload – Independent Study	100	
Module outcomes		
	At the end of the module students should: • develop skill of deductive reasoning; • know and comprehend the concepts of limits and continuity; be familiar of how to synthesize intuitive concepts into precise mathematical formulation; • apply standard tests and criterions for convergence of both sequences and series, as well as methods for evaluating limits of sequences and single variable real functions; • comprehend the role of linearization in mathematical modeling of actual physical and other problems; • know and comprehend the concepts of derivative, primitive function (anti-derivative), indefinite and definite (Riemann) integral and their basic properties; • apply the basic techniques of differential and integral calculus of single variable real functions; • further develop the notion of convergence through examination of sequences and series of functions.	
Module content		
	1. Numbers and general concepts about numeric functions: Algebraic operations involving real numbers. Decimal representation of real numbers. Triangle inequality. Bounded and unbounded intervals. General concepts on real-valued functions of a single real variable. Bounded, monotone, symmetric (even and odd), periodic functions. Functions composition, identity maps, injective functions, inverses. Elementary functions: power function (with real exponent), exponential and logarithmic functions, hyperbolic and their inverse functions, trigonometric and their inverse functions. **2. Single variable real functions I:** Limits and asymptotes: Neighborhood and infinity on real axis. Limit (finite and infinite) of a function at a point and at infinity. One-sided limits: from the left and from the right. Inequalities for limits of functions. Algebraic operations with limits. Indefinite expressions. Limit existence of	

a monotone function. Limit inferior and limit superior of a monotone function. Techniques for evaluating a limit. Limits for common functions (power, exponential, logarithmic and trigonometric functions). Hierarchy of infinity: logarithms, power functions, exponential functions. Application of asymptotic expansions for evaluations of limits. Asymptotes: horizontal, vertical and oblique (slant).

3. **Single variable real functions II:**
Mean-value theorem and Bolzano's theorem for continuous functions on an interval. Definition of continuous functions on an interval. Continuity of inverse function to a continuous monotone function on an interval. Continuity of elementary functions and algebraic combinations of continuous functions. Point of absolute maximum and minimum of a function. Weierstrass' theorem about minimum and maximum of continuous functions on a segment.

4. **Complex numbers**:
Algebraic form: real and imaginary part, modulus, conjugated complex numbers and their properties. Triangle inequality. Argument. Trigonometric form. De Moivre's theorem about product, quotient and power of complex numbers, n^{th} root of a complex number.

5. **Infinite sequences and series of numbers and functions:**
Concept of an (infinite) series, n^{th} partial sum. Convergence and divergence, regular and alternating series. Geometric series. Necessary condition for convergence of series; harmonic series. Series with non-negative terms, (limit) comparison test, (limit) ratio test, (limit) root test. General harmonic series. Absolute and conditional convergence of infinite series. Absolute convergence is sufficient for ordinary convergence. Leibniz criterion for alternating series. Complex sequences and series. Infinite sequences and series of functions: uniform convergence, Cauchy and Weirestrass criterion of uniform convergence; power series with complex terms, Taylor and Laurent series.

6. **Differential calculus of single variable real functions I:**
Differentiability and properties of differentiable functions. Derivate of a function at a point. Left and right derivatives. Tangent line to the graph of a function. Differentiation rules of elementary functions. Derivatives of compositions and inverses. The connection between continuity and differentiability of functions at a point. Theorems of Fermat, Rolle and Lagrange (mean-value). Properties of monotone differentiable function at an interval determined with the sign of derivative. Function with zero derivative at an interval.

7. **Differential calculus of single variable real functions II:**
Derivatives of higher order, finding extrema and linear approximations. Concavity and convexity. Flexion: definition and application of second derivative. Application of first and second derivatives to examination of a graph of a function. L'Hospital rule. Taylor series. Remainder of an approximation of second order in Peano's and Lagrange's form

8. **Integral calculus of single variable real functions I:**
(Definite/Riemann) integral, primitive functions and fundamental theorems. Riemann integral single variable real functions defined of closed intervals. Basic properties of definite integrals. Mean-value theorem. Primitive and integral functions defined on an interval. Fundamental theorems of integral calculus. Definition and basic properties of indefinite integral.

9. **Integral calculus of single variable real functions II:**
(Methods of integration and improper integrals). Methods for evaluation of definite and indefinite integrals. Integration by substitution and integration by parts. Techniques for finding integrals of some classes of functions (rational, trigonometric, irrational). Definition of improper

	integral. Integrability criterion: (limit) comparison criterion.	
Literature		
Recommended	1. H. Fatkić: *Inženjerska matematika 1*, Slajdovi i bilješke, Sarajevo, 2013, http://www.etf.unsa.ba/. 2. H. Fatkić: *Inženjerska matematika 1*, Štamparija Fojnica d.d., Fojnica-Sarajevo, 2012. (University book) 3. M. Merkle: *Matematička analiza*, Akademska misao, Beograd, 2001. 4. H. Fatkić, B. Mesihović: *Zbirka riješenih zadataka iz matematike I*, ETF, Sarajevo, 1973.; Corons, Sarajevo, 2002. 5. M. P. Uščumlić, P. M. Miličić: *Zbirka zadataka iz više matematike I i II*, Građevinska knjiga, Beograd, 2004.	
Additional	1. D. Adnađević, Z. Kadelburg, *Matematička analiza I*, Nauka, Beograd, 1995. 2. T. M. Apostol: *Calculus I*, Blaisdell Publ. Co., New York, 1961. 3. T. M. Apostol: *Mathematical Analysis* (2nd ed.), Addison – Wesley Publ. Co., London, 1974. 4. A. Croft, R. Davison, M. Hargreaves: *Engineering Mathematics*, Addison-Wesley Publishing Company Inc. Harlow,1996. 5. V. Dragičević, H. Fatkić: *Određeni i višestruki integrali*,Svjetlost, Zavod za udžbenike, Sarajevo, 1979; 2. izd. 1987. (Textbook) 6. D. Jukić, R. Scitovski: *MatematikaI*, Elektrotehnički fakultet & Prehrambeno-tehnološkifakultet – Odjel za matematiku, Sveučilište J. J. Strossmayera u Osijeku, Osijek, 2000. 7. J. Lewin, *An interactive introduction to mathematical analysis. With CD-ROM*, Cambridge: Cambridge University Press, 2003. 8. Ž. Marković: *Uvod u višu analizu*, I. dio, Školska knjiga, Zagreb, 1956. 9. M. Pašić: *MatematikaI*. S više od 800 primjera i zadataka, Merkur ABD, Zagreb, 2005. 10. R. Živković, H. Fatkić, Z. Stupar: *Zbirka zadataka iz matematikesa rješenjima,uputama i rezultatima* (Matematička logika i skupovi, Relacije i funkcije, Algebarske strukture, Brojevi, Jednačine i nejednačine, Polinomi, Aritmetički niz i geometrijski niz), Svjetlost - OOUR Zavod za udžbenike i nastavna sredstva, Sarajevo, 1987. (Book)	
Didactic methods		
	The course is carried out through theoretical lectures that serve to present the concepts of differential and integral calculus for *real functions* of a *real* variable. These lectures are supported by solving of mathematical problems by lecturers with the goal of having the students master the instruments and methods introduced in lectures. Under guidance and monitoring by academic tutors, other mathematical problems, including the ones from pervious exam terms, are solved as well. These activities are organised in a way that the level of students' preparedness to master the knowledge and skills they need to acquire during the course is continuously checked through the curriculum which includes homework and partial exams.	
Assessment		
	Student collects points during the course based on the following system*): – attendance at lectures and tutorials carries 10 points; student who misses three or more lectures and/or tutorials cannot collect points on this basis; – homework carries maximum 10 points; students need to prepare 3 to 5 homework assignments that are equally distributed during semester; – Partial exams: two partial exams, out of which each carries maximum 20 points. Partial exams (90 minutes long) carry tests comprised of multiple choice answers, out of which only one is the correct one (student who answers correctly to all the multiple choice tests achieves maximum 10 points), as well	

	as one open answer test (correct answer to this test brings 10 points). Students who passed both partial exams in a semester (achieved 10 or more points at each test) takes the final oral exam; this exam is comprised of discussion on assignments from partial exams, homework, and answers to simple questions which refer to the topic of the course (definitions, formulations, and presentation of simpler evidence of the most important traits and/or theorems. Final oral exam is focused on integral matter of the course stipulated by study programme. The goal of this exam is to check whether students achieved adequate understanding of concepts and practical matters presented during the course. Final oral exam carries maximum 40 points. In order to achieve passing grade, students have to achieve minimum 15 points at this exam. Students who don't achieve minimum number of points will take oral part of makeup exam. Students who fail both partial exams will take makeup exam. Makeup exam is organised in the following way: – written part, which is structured the same way as partial written exam; within this exam students will take the tests from partial exam in which they failed to achieve a passing grade (10 or more points); – oral part, which is structured the same way as oral part of the final exam. Students who achieved total score of 10 or more points in each of the two partial exams after taking the written part of makeup exam are eligible to take the oral part of makeup exam; the score is comprised of points collected through passing of partial exams and passing of written part of makeup exam. Oral makeup test carries maximum 40 points. In order to get a passing grade, students need to achieve minimum 15 points in this exam and at the same time achieve minimum 55 points out of possible 100 (including the points for attendance, homework, and two partial exams passed). Students who do not achieve these minimums have to retake the course. ---------- *) Attendance at all aspects of teaching is mandatory.	
Prerequisites		

Module title	Fundamentals of Electrical Engineering	
Module code	ETF OE I-1175	
Programme	ETF-B PE, ACE, TC, CI	
Module coordinator	Dr Narcis Behlilović, Full Professor Dr Senad Smaka, Assistant Professor	
Teaching staff	Mirza Milišić, MSc, Senior Teaching Assistant Mirza Hamza, MSc, Senior Teaching Assistant Irma Sokolović, MSc, Senior Teaching Assistant Mirsad Ćosović, Teaching Assistant Lejla Ahmethodžić, Teaching Assistant	
Year of study	1	
Semester	1	
Module type	Mandatory	
ECTS	7	
Lectures	48	
Laboratory exercises	4	
Tutorials	28	
Workload – Independent Study	95	

Module outcomes		
	Module has a goal to present basic concepts of electro-magnetism to the students, with appropriate mathematical apparatus. Students gain knowledge related to scientific methodology and natural laws in such manner to meet electro-magnetic phenomena and problems related, from qualitative and quantitative aspect.	
Module content		
	1. Electric charge: insulators and conductors, Coulomb's law of force, distributions of electric charge. 2. Electric field: Gauss's theorem for electric field in integral and differential form, divergence of electric field, examples of application of Gauss's theorem. 3. Electric potential: work of electric field forces, conservative nature of electric field, curl of electric field. Potential and difference of potentials, Electric field as gradient of potential, equipotent planes. Poisson's and Laplace's equations. 4. Electric capacity: Definition of electric capacity, capacity in system of conductors, examples of capacity calculation. Combinations of capacitors. Electro-static energy and calculation of force using electrostatic energy. 5. Dielectrics: matter polarization, electric susceptibility and nature of polarization vector. Dielectric displacement and its connection with dielectric electrostatic field and polarization. Boundary conditions between two linear dielectric environments. Stored energy in dielectric medium. 6. Electric current: definition of electrical conductivity and stationary electric current, Ohm's law of electrical conductivity, electric resistance, serial and parallel connected resistors. Joule's law. Exchange of energy in electrical circuit. Kirchhoff's laws. Energy conservation law in electrical circuit. 7. Magnetic field: magnetic interaction, electricity and magnetism. Magnetic force to electric charge in motion, magnetic force to conductor conducting electricity, mechanical moments. Hall's effect. Motion of charged particle in magnetic field. 8. Sources of magnetic field, Ampere's law in basic and general form, magnetic properties of matter, electrically induced magnetic field, Biot-Savart-Laplace's law, electro-dynamic force, magnetic properties of matter: permeability and susceptibility of material, hysteretic loop, Gauss's law for magnetic field. 9. Basic magnetic circuits: Analogy with electric circuits. 10. Time-variable electric and magnetic fields: Properties of electromagnetic field, Faraday's law of electromagnetic induction, Lenz's principle, induced electromotive force. Application of Faraday's law: alternating current generators, electric motors. Self-induction, inductive electric circuit, magnetic energy in linear and non-linear environments. Mutual induction, calculation of mutual inductivity.	
Literature		
Recommended	1. Notes and slides from lectures (See Faculty WEB Site) 2. N. Behlilović, Osnove Elektrotehnike, Univerzitet u Sarajevu, ISBN 978-0058-629-24-2, COBISS.BH-ID 16925446, Sarajevo 2008.	
Additional	1. Ejup Hot, Osnovi elektrotehnike knjiga prva, Ejup Hot, Osnovi elektrotehnike knjiga druga, ETF Sarajevo 2003. 2. Umran S. Inan, Aziz S. Inan, Engineering Electromagnetic, Addison Wesley Longman, Inc. 1998, California, USA.	
Didactic methods		
	Lectures are presented directly in lecture-hall and are being supported with typical problems solving (48 hrs) in such manner for students to comprehend and adopt knowledge and skills defined in module outcomes.	

	Throughout laboratory exercises (4 hrs), under guidance of tutor, experiments are carried out in laboratory. Goal of laboratory exercises is for students to practically verify (by forming some simple DC circuits) some fundamental laws presented in lectures (such as: Ohm's law, I&II Kirchoff's law, energy conservation law, etc.). Throughout tutorials (28 hrs), under guidance of tutor, typical problems are solved (from topics treated in lectures), including problems from previous exams. In this manner students will be prepared for final exam.	
Assessment		
	The contributions of all activities are rated according to the following scale: • Regular attendance (max. 10 points) • Homeworks / Laboratory exercises (max. 10 points) • 1st midterm exam (max. 20 points) • 2nd midterm exam (max. 20 points) • Final exam (max. 40 points) Regular attendance means that student must be present on all forms of the module's delivery. Student earns 10 x (Number of presence hours) / 60 points for attendance. By solving of homework and/or laboratory exercises (HW/LE), student can earn up to 10 points. Homework is done in the form of preparation and implementation of laboratory exercises under the guidance of assistant (2x2 points) and two short tests (2x3 points). Midterm exams: There are two midterm exams, and both are in written form. At each midterm exam student can earn a maximum of 20 points. Midterm exam is considered to be passed by a student if he earned at least 10 points. First midterm exam is in the 8th week, and second midterm exam is in the 16th week of the semester. Students who failed first and/or second midterm exam are allowed to go through the makeup exam at the end of the semester. Duration of midterm and makeup exams is from 90 to 120 minutes. During midterm and makeup exams students solve the problems that are of the same type as those solved during the lectures and tutorials. Final exam: At final exam, a student can earn a maximum of 40 points. Student will be allowed to take final exam if he/she meets all of the following conditions: • if student passes both midterm exams, • if student earns at least 40 points through: regular attendance, and homework/laboratory, and midterm exams. Final exam is considered to be passed if a student earns a minimum of 15 points. Otherwise, student must take makeup final exam (which is just as structured as the final exam.). Final exam can be written or oral and most frequently is in oral form. At final exam students get three questions related to course topics. Makeup exams and makeup final exam: Students who fail the midterm exam(s) must take the makeup exam. Also, students who fail to earn 40 points (through: regular attendance, and homework/laboratory, and midterm exams), regardless of whether they have passed the midterm exams or not, must take makeup exam. Students who failed final exam must take makeup final exam. Also, students will be allowed to take makeup final exam if they meet all of the following conditions: • if student passes makeup exam, • if student earns at least 40 points through: regular attendance, and homework/laboratory, and midterm exams. Students who fail to earn at least 20 points (through: regular attendance, and homework/laboratory, and midterm exams), regardless of whether they have	

	passed the midterm exams or not, must retake this module next academic year. Also, students who do not achieve a minimum of 15 points at makeup final exam must retake this module next academic year.	
Prerequisites		

Module title	Physics for Engineers 1	
Module code	ETF IF1 I-1160	
Programme	ETF-B PE, ACE, TC, CI	
Module coordinator	Dr Hasnija Šamić, Associate Professor	
Teaching staff	Dr Hasnija Šamić, Associate Professor Selma Hanjalić, MSc, Senior Teaching Assistant Bojan Nikolić, Teaching Assistant	
Year of study	1	
Semester	1	
Module type	Mandatory	
ECTS	6	
Lectures	39	
Laboratory exercises	0	
Tutorials	21	
Workload – Independent Study	65	
Module outcomes		
	The course aims to provide an introduction to classical mechanics necessary for basic formation of future engineers, and its preparation for advanced courses. At the end of the module students should: • understand the basic concepts of mechanics of material point, system of points and fluids and apply them in specific cases, • be able to define, discuss, analyze, and solve simple problems of classical mechanics, correctly applying the basic concepts of vector algebra and mathematics analyzes.	
Module content		
	Matter is systematized and divided into the following chapters: **1. Physical fundamentals of mechanics:** Physical values and measurements; measure units and unit systems; measurement errors; scalar and vector values; material point and system of material points (solid). **2. Kinematics:** Kinematics of material point; space and time; movement and referent systems; displacement, velocity and acceleration of material point; types of kinematic movements, rectilinear movement, curvilinear movement. **3. Dynamics:** 3.1. The fundamental equation of dynamics: Causes that lead to movement of the body; the first, second and third Newton's principle of dynamics; differential equations of motion under force in gravitational, electric and magnetic field; torque force and impulse; work and energy; power; laws of conservation of energy and impulse; body collisions. 3.2. Dinamycs of solid body: Inertia moment; Steiner theorem; force momentum; impulse momentum; work and energy of rotation; law of conservation of impulse momentum.	

	4. Oscillations: Oscillatory movement; harmonic oscillations; energy of the harmonic oscillation; composition of harmonic movements; mathematical, physical and torsional pendulum; damped oscillations; forced oscillations; resonance. **5. Waves:** 5.1. Mechanical waves: Definition of wave motion; plane and spherical waves; the general wave equation; energy of elastic waves; wave interference; standing waves; wave reflection; refraction of waves. 5.2. Sound: Sound waves; propagation speed of sound waves; Doppler effect; volume level; sound absorption; ultrasound. **6. Mechanics of fluids:** 6.1. Fluid statics: The pressure; hydrostatic pressure; atmospheric pressure; Archimedes law. 6.2. Fluid dynamics: Ideal fluid flow; equation of continuity; Bernoulli's equation; viscosity; laminar and turbulent motion; movement in the pipes with variable cross-section; measuring the speed and flow.	
Literature		
Recommended	1. H.Šamić, Inženjerska fizika 1, Slajdovi i bilješke, http://www.etf.unsa.ba/ 2. S.Marić, "Fizika", Svjetlost, 2001. 3. H.Šamić, B.Nikolić, S.Hanjalić "Inženjerska fizika 1 – odabrani problemi sa rješenjima", Sarajevo, 2013. 4. D.Halliday, R.Resnick, J.Walker, "Fundamenatls of Physics", John Wiley & Sons, 2001.	
Additional	1. D.Giancoli, "Physics for Scientists and Engineers", Prentice Hall, New Jersey, 2000.	
Didactic methods		
	Course material is presented in following ways: lectures and tutorials. Lectures performed in an aula for all students by the teacher. During those lectures, fundamental theoretical and experimental aspects of matter will be explained. In addition, numerical problems will be solved. After completion of the presentation for each logical unit rounded curriculum, teacher will formulate and solve problems, and examples that allow students to understand the tools and methodologies provided during lectures. In tutorials, under the guidance of the teaching assistant, more numerical problems and examples are solved in order to achieve a better theoretical understanding of the presented topics. Students are divided into small groups and can be prepared for tutorial classes and present the planned tasks for such activity to get extra points. During the semester, students are obliged to do five homeworks. In addition, students are expected to participate in lectures and tutorials, as well as to work individually all the time.	
Assessment		
	During the course, students earn points according to the following system: • Attendance to lectures and tutorials: 10 points. Student with more than three absences during semester will not get there points. • Homeworks – maximum of 10 points. Students will have five homeworks equally distributed throughout the semester. • Two written exams, midterm and final, each written exam with a maximum of 40 points. Partial exam lasts 90 minutes and the student responds to three theoretical issues and solves three numerical problems. To successfully complete a course the student should gain at least 60 points during the course. The final oral exam is optional and applies only to students who are not satisfied with the proposed final grade. The proposal of the final grade is	

	formed on the basis of evidence of the presence of all forms of teaching, performance on written exams and activities in tutorials. In the oral examination students answer the theoretical questions related to the topic from the course. Student who earns less than 20 points must retake the course. Student who earns less than 60 points during one semester and less than 20 points on the one partial exam will have to take a partial makeup exam, for the part that he failed. If student failed both partial exams, will have to take an integral makeup exam, maximum of 80 points, which consists of four theoretical issues and four numerical problems. Makeup integral exam lasts 150 minutes.	
Prerequisites		

Module title	Linear Algebra and Geometry	
Module code	ETF LAG I-1160	
Programme	ETF-B PE, ACE, TC, CI	
Module coordinator	Dr Almasa Odžak, Assistant Professor	
Teaching staff	Dr Almasa Odžak, Assistant Professor Mirza Batalović, MSc, Senior Teaching Assistant Selma Grebović, MoE, Teaching Assistant	
Year of study	1	
Semester	1	
Module type	Mandatory	
ECTS	5	
Lectures	39	
Laboratory exercises	0	
Tutorials	21	
Workload – Independent Study	60	
Module outcomes		
	At the end of the module students should be able: • to understand idea of vector space, linear dependence and independence, vector space basis and dimension, linear mapping of vector spaces, • to overwhelm the techniques of matrices and vectors calculations, • to analyze a solvability of linear equation systems and to be able to find their solutions using different techniques, • to overwhelm the concept of straight line and plain, as well as the concept of curves and surfaces in the space, • to use achieved knowledge in order to solve particular practical problems.	
Module content		
	1. **Elements of mathematical logics and set theory**: Operations. Algebraic structures. Group, rings and modules. 2. **Vector spaces theory elements**: Vector spaces and subspaces. Calculation properties. Linear combinations. Linear dependence and independence. Basis, dimension and generators. 3. **Matrices**: Definition and types of matrices. Operations (addition, multiplication by scalars, multiplication, transposition). Matrix rank. Inverse matrix. Determinants (presenting, Sarrus rule, Laplace rule, properties).	

	4. **Systems of linear equations**: Definitions of systems of linear equations and solutions. Determined, undetermined and impossible system. Cramer's rule. Method for solving quadratic systems using matrices. Gauss elimination method. Kronecker-Capelli method. 5. **Linear operators**: Definition of linear operator. Kernel and image of an operator. Linear operators and matrices. Linear functionals and dual vector spaces. Polynomials. Eigenvalues and Eigenvectors. Diagonalization. 6. **Vector algebra**: Definition of vectors. Magnitude and direction. Basic vector operations. Dot, cross and triple product of vectors. 7. **Analytical geometry in plane:** Concept of line and surface equation. Equations of a line in the plane. Parallel and perpendicular lines. The distance between two points. Set of lines passing through specific point in the plane. 8. **Second order curves:** Ellipse, hyperbola, parabola. Second order curves identification. 9. **Analytical geometry in space**: Equations of a plane in space. Equations of a line in space. Mutual relations between two lines, two planes, and plane and line in space. Set of plains containing specific line. 10. **Second order surfaces**: Ellipsoid. Hyperboloid. Elliptical paraboloid. Hyperbolic paraboloid. Cylinder. Cone. Surface of revolution.	
Literature		
Recommended	1. A. Odžak: Lecture notes, Sarajevo, 2013, http://www.etf.unsa.ba/ 2. D. S. Mitrinović, D. Mihailović, P. M. Vasić: Linearna algebra, polinomi i analitička geometrija, Građevinska knjiga Beograd,1990. 3. B. Mesihović, Š. Arslanagić: Zbirka riješenih zadataka i problema iz matematike sa osnovma teorije i ispitni zadaci, Svjetlost, Sarajevo, 1988. 4. P. Miličić, M. Ušćumlić: Zbirka zadataka iz matematike I, Beograd, 1989.	
Additional	1. G. Strang: Introduction to Linear Algebra. 4th ed. Wellesley-Cambridge Press, 2009. 2. L.E. Spence, A.J. Insel, S.H. Friedberg: Elementary Linear Algebra: A Matrix Approach, 2nd ed , Pearson, 2008. 3. O. Bretcher: Linear Algebra with Applications, Pearson, New Jersey, 2009. 4. M. Bračković: Matematika – determinante, sistemi linearnih jednačina, elementi vektorske algebre i analitičke geometrije, Svjetlost, Sarajevo, 1990. 5. N. Elezović: Linearna algebra, Element, Zagreb, 1996. 6. N. Elezović, A. Aglić: Linearna algebra, Zbirka zadataka, Element, Zagreb, 1996.	
Didactic methods		
	The main goal of lectures is to give exhaustive overview of all topics covered by this module. Monologue, dialog and demonstrative methods are being used here. After introducing the terms, their mutual relationships, results and methods of particular topic the lecturer solves carefully selected examples in order to demonstrate previously theoretically lectured material. During tutorials, under the tutor guidance, theoretical elements of particular topic are being resumed and carefully selected examples and problems are solved in details. During tutorials students are able to use an opportunity for interactive discussion about issues that are subject of the course. Besides that, small number of students in groups for tutorials gives an insight of student's achievement during the course. Students are obligated to attend lectures and tutorials. It is expected that each student is properly prepared for all forms of classes using teaching materials available to be downloaded from the faculty courseware, and to actively	

	participate during classes and to maintain continuous independent study.	
Assessment		
	The assessment activities and their allocated points are given in details below. Activity: Mark (%): Class Participation & Attentiveness 10 % Homework assignments 10 % Partial examination 1 (week 8) 20 % Partial examination 2 (week 16) 20 % Final examination 40 % **Class participation and attentiveness:** Attentive participation in all forms of classes is mandatory. **Homework assignments:** Two homework assignments are anticipated during the course. Each homework consists of 5-10 problems to be solved. Solving homework problems student needs to demonstrate certain competency for independent usage of methods and techniques displayed during the hours of lectures and tutorials. **Partial examination:** The partial examination in this course are standard closed-book, 2 hours written examination, covering all aspects of the course that have been presented in the lectures and tutorials during previous seven weeks. The exams consist of some questions of a descriptive nature (e.g. explaining a concept, main results and techniques) and the rest are problem-solving questions. Through this exam analytical and critical thinking and general understanding of the course material is verified in a controlled fashion. Assessment is a graded according to the correct fraction of the answers to the exam questions. A satisfactory performance (50% or greater) in the both partial exams is a necessary requirement to pass this course, irrespective of the marks obtained in the other components. **Final examination**: The final oral exam covers all topics of the module. The objective is to ensure that the student has an appropriate understanding of the concepts, results and methods of the course.	
Prerequisites		

Module title	Mathematics for Engineers 2	
Module code	ETF IM2 I-1280	
Programme	ETF-B PE, ACE, TC, CI	
Module coordinator	Dr Huse Fatkić, Associate Professor	
Teaching staff	Dr Huse Fatkić, Associate Professor Alvin Abdagić, MoE, Teaching Assistant Mehmed Brkić, MoE, Teaching Assistant	
Year of study	1	
Semester	2	
Module type	Mandatory	
ECTS	7	
Lectures	52	
Laboratory exercises	0	
Tutorials	28	
Workload – Independent	100	

Study		
Module outcomes		
	After completing the course the student should: • develop a sense of creativity; • master the standard techniques of solving basic types of simple differential equations of the first and higher order and system of linear differential equations; • understand the concepts of the Laplace transform, Fourier series, Fourier transform, Fourier integral and a good knowledge of their basic components and important applications; • grasp the basic techniques of differential and integral calculus of real and vector functions of several real variables and enable them for their application in physics and other natural sciences; • acquire the necessary knowledge about optimization problems applying standard and conditional extreme of functions of multiple variables; • understand basic terms of theory of scalar and vector fields as well as knowing their basic properties; • understand the role which differential equations and the theory of functions of several variables have in mathematical modeling of concrete physical and other problems.	
Module content		
	1. Ordinary differential equations of the first order: Basic concepts and ideas. Geometrical consideration. Isoclines. Sepparation of variables. Linear differential equations of the first order. Variation of constants. 2. **Ordinary differential equations of the higher order:** Homogeneous linear differential equations of second order with constant coefficients. General solution. Cauchy's equation. Homogeneous differential equations of higher order with constant coefficients. Nonhomogeneous linear differential equations. General method for solving nonhomogeneous equations. Systems of differential equations. **3. Laplace transform:** Direct and inverse Laplace transform. Basic properties. Laplace transform of derivatives and integrals. Transformation of ordinary differential equations. Unit step function. Periodic functions. **4. Fourier series, integrals and transforms:** Periodic functions. Trigonometrical series. Fourier series. Euler's formulas. Functions with arbitrary period. Even and odd functions. Fourier integrals. Fourier transform. 5. **Basis of differential calculus of functions of several real variables:** Functions of several real variables. Continuity. Limits. Polar coordinates in the plane. Calculating limits using a coordinate transformation. Directional derivative. Higher order partial derivatives. Gradient. Derivative of a composite function. **6. Taylor's formula – Optimization I:** Local extreme. Necessary condition for existing local extremes (Fermat's theorem). Second order derivative of scalar function of two variables. Quadratic forms, classification. Necessary condition for the local extreme to have an inner point. Sufficient condition for local extreme. 7. **Optimization II (Relative extreme-relative maximum or minimum):** Presentation of curve and surface in implicit form. Tangent space and normal space on the curve given by the equation f (x, y) = 0. Equation of a tangent, equation of a tangent plane and equation(s) of the normal line. Points in which there is related extreme. Critical points. Gradient in a critical point. Necessary condition for the local extreme of function defined on the curve or surface (interpretation of the Lagrange	

	multipliers and applications to optimization problems). **8. Vector field theory:** Scalar and vector fields. Vector calculus. Curves. Arc length. Tangent. Curvature and involution. Speed and acceleration. Directional derivative. Gradient of a scalar field. Divergence and rotor of vector fields. **9. Integral calculus of functions of several real variables:** Line integrals of the first and second kind. Double and iterated integrals. Transformation of double integrals into line integrals. Surfaces. Tangent plane. Surface integrals of the first and second kind. Triple, iterated and multiple integrals. Gauss' divergence theorem. Stokes' theorem. Consequences and applications of Gauss' and Stokes' theorems. Line integrals & independence of path.	
Literature		
Recommended	1. H. Fatkić: *Inženjerska matematika* 2, Slajdovi i bilješke, Sarajevo, 2013, http://www.etf.unsa.ba/. 2. H. Fatkić, V. Dragičević, *Diferencijalni račun funkcija dviju i više promjenjivih*, I.P. Svjetlost, Sarajevo, 2006. (University book) 3. D. Mihailović, D. Đ. Tošić, *Elementi matematičke analize II*, (*Funkcije više promjenljivih, vektorska analiza, višestruki integrali i teorija polja*), Naučna knjiga, Beograd, 1976; 1988; 1991. (Textbook) 4. P. M. Miličić, M. P. Uščumlić: *Zbirka zadataka iz više matematike II*, Građevinska knjiga, Beograd, 1971; ..., 1988. 5.M. Pašić, *Matematika* 2 *sa zbirkom riješenih primjera i zadataka*, Merkur A.B.D., Zagreb, 2006.	
Additional	1. T. M. Apostol, *Calculus*, Vol. II, Second Edition, (1967), and the additional course notes by James Raymond Munkres, Professor of Mathematics, Emeritus (at MIT). 2. A. Dautović, *Laplaceova transformacija - Zbirka riješenih zadataka*, ETF, Sarajevo, 2010. 3. B. P. Demidović i dr., *Zadaci i riješeni primjeri iz više matematike s primjenom na tehničke nauke* (prijevod), Tehnička knjiga, Zagreb, 1971; Danjar, Zagreb, 1995. 4. V. Dragičević, H. Fatkić, *Određeni i višestruki integrali* , IGKRO Svjetlost, Zavod za udžbenike, Sarajevo, 1979. (I. izd.); 1987. (II izd.). (Textbook)) 5. M. Galić, E. Osmanagić, *Matematika III, Normirani i metrički prostori, diferencijalne jednačine i redovi*, Elektrotehnički fakultet, Sarajevo, 1977. 6. S. Kurepa, *Matematička analiza. Treći dio. Funkcije više varijabli*, Tehnička knjiga, Zagreb, 1975. 7. M. Nurkanović, Z. Nurkanović, *Laplaceova transformacija i primjena*, PrintCom d.o.o. grafički inženjering, Tuzla, 2010. 8. F. Vajzović, M. Malenica, *Diferencijalni i integralni račun funkcija više promjenljivih,* Univerzitetska knjiga, Studentska štamparija Univerziteta u Sarajevu, Sarajevo, 2002. (University book) 9. M. Vuković, *Diferencijalne jednačine,* Prvi dio, Univerzitetska knjiga, Studentska štamparija Univerziteta u Sarajevu, Sarajevo, 2000. (University book)	
Didactic methods		
	The course is carried out through theoretical lectures that serve to present the concepts of differential and integral calculus for real functions of a real variable. These lectures are supported by solving of mathematical problems by lecturers with the goal of having the students master the instruments and methods introduced in lectures. Under guidance and monitoring by academic tutors, other mathematical problems, including the ones from pervious exam terms, are solved as well. These activities are organised in a way that the level of students' preparedness	

	to master the knowledge and skills they need to acquire during the course is continuously checked through the curriculum which includes homework and partial exams.	
Assessment		
	Student collects points during the course based on the following system*): – attendance at lectures and tutorials carries 10 points; student who misses three or more lectures and/or tutorials cannot collect points on this basis; – homework carries maximum 10 points; students need to prepare 3 to 5 homework assignments that are equally distributed during semester; – Partial exams: two partial exams, out of which each carries maximum 20 points. Partial exams (90 minutes long) carry tests comprised of multiple choice answers, out of which only one is the correct one (student who answers correctly to all the multiple choice tests achieves maximum 10 points), as well as one open answer test (correct answer to this test brings 10 points). Students who passed both partial exams in a semester (achieved 10 or more points at each test) takes the final oral exam; this exam is comprised of discussion on assignments from partial exams, homework, and answers to simple questions which refer to the topic of the course (definitions, formulations, and presentation of simpler evidence of the most important traits and/or theorems. Final oral exam is focused on integral matter of the course stipulated by study programme. The goal of this exam is to check whether students achieved adequate understanding of concepts and practical matters presented during the course. Final oral exam carries maximum 40 points. In order to achieve passing grade, students have to achieve minimum 15 points at this exam. Students who don't achieve minimum number of points will take oral part of makeup exam. Students who fail both partial exams will take makeup exam. Makeup exam is organised in the following way: – written part, which is structured the same way as partial written exam; within this exam students will take the tests from partial exam in which they failed to achieve a passing grade (10 or more points); – oral part, which is structured the same way as oral part of the final exam. Students who achieved total score of 10 or more points in each of the two partial exams after taking the written part of makeup exam are eligible to take the oral part of makeup exam; the score is comprised of points collected through passing of partial exams and passing of written part of makeup exam. Oral makeup test carries maximum 40 points. In order to get a passing grade, students need to achieve minimum 15 points in this exam and at the same time achieve minimum 55 points out of possible 100 (including the points for attendance, homework, and two partial exams passed). Students who do not achieve these minimums have to retake the course. ---------- *) Attendance at all aspects of teaching is mandatory.	
Prerequisites		
	Mathematics for Engineers 1	

Module title	Physics for Engineers 2	
Module code	ETF IF2 I-1260	
Programme	ETF-B PE, ACE, TC, CI	
Module coordinator	Dr Hasnija Šamić, Associate Professor	
Teaching staff	Dr Hasnija Šamić, Associate Professor Selma Hanjalić, MSc, Senior Teaching Assistant Bojan Nikolić, Teaching Assistant	

Year of study	1	
Semester	2	
Module type	Mandatory	
ECTS	5	
Lectures	39	
Laboratory exercises	0	
Tutorials	21	
Workload – Independent Study	65	
Module outcomes		
	After successfully completion of this course, students will be able to understand basic principles and methodologies from the field of applied thermodynamics, mechanism of heat transfer, optics and modern physics. They will know to define, discuss, analyze and solve problems which require knowledge of principles from the various fields of physics necessary for future engineers. Also, these students will improve their critical thinking. They will know which information they need for solving different problems and where and how these information can be found. Finally, students who successfully complete this course will be prepared to apply their knowledge in problems that will be studied in advanced courses.	
Module content		
	1. **Thermodynamics:** ideal gases - properties, temperature, phase changes, specific heat, mixtures of ideal gases, Dalton's law, first law of thermodynamics, enthalpy, second law of thermodynamics, reversibility, Carnot's theorem, entropy, third law of thermodynamics, entropy and work, thermo-electric effects, first law of thermodynamics for open systems, p-V diagram, thermodynamic properties of fluids, Rankine's cycle, refrigerator cycle. 2. **Heat transfer:** conduction, convection, radiation, Fourier's law, stationary conduction**.** 3. **Optics:** the nature of light, reflection and refraction, total internal reflection, spherical mirrors, dispersion, Huygens's principle, thin lenses, the magnifier, microscopes and telescopes, interference and diffraction of light, polarization, luminous flux, intensity of light, illumination, photometer. 4. **Radiation:** general concepts and definitions, black body, radiation laws, exchange of energy, convection and radiation, Planck's law. 5. **Principle of the modern physics**: photo effect, x-rays, Compton's effect. 6. **Atomic and nuclear physics:** Rutherford – Bohr's model of atom, wave properties of particles, Schrödinger equation, properties of atoms, spectra, radioactivity, nuclear reactions, elementary particles.	
Literature		
Recommended	1. Notes and slides from the lectures, http://www.etf.unsa.ba 2. S. Marić: "Fizika", Svjetlost, 2001. 3. H. Šamić, B.Nikolić, S.Hanjalić: "Inženjerska fizika 2 - odabrani problemi sa rješenjima", 2013. 4. D. Halliday, R. Resnick, J. Walker: "Fundamenatls of Physics", John Wiley & Sons, 2001.	
Additional	1. D. Giancoli: "Physics for Scientists and Engineers", Prentice Hall, New Jersey, 2000.	
Didactic methods		

	Module content delivery is performed through two activities: lectures and tutorials. Lectures in a lecture hall for all students, presented by lecturer, during which theoretical and experimental aspects of the course subjects are presented followed by solving numerical problems. Lectures have a goal to provide students with comprehensive frame of all program parts. After the end of presentation for each logically rounded unit of the curriculum, lecturer will formulate and solve examples and problems enabling students to comprehend instruments and methodologies given during lectures. Other examples and problems will be considered and solved during tutorials (under guidance of a teaching assistant). Students are separated in smaller groups and they are informed in advance about problems that will be discussed on upcoming tutorials. Students are encouraged to prepare themselves for the classes and to solve the problems and present their solutions to the other students in the group by rewarding them with the points for their activity on tutorials. During the semester, students are obliged to do five homeworks. In addition, students are expected to participate in lectures and tutorials, as well as to work individually all the time.	
Assessment		
	Students need to collect at least 60 points during the academic year to pass exam (and at least 40 points must be collected through partial or make up exams). • Students collect 10 points by attending classes and tutorials. Student with more then three absences from tutorials and lectures can not get these points. • Students have 5 homeworks during semester. Homeworks can bring to students a maximum of 10 points. • There are two partial exams during semester. The partial exam consists of three theoretical questions and three problems. Students have 90 minutes to solve them. Students can score a maximum of 40 points on each partial exam. The final grade will be proposed to the students who collect 60 or more points during an academic year. The proposal of the final grade is formed on the basis of the number of collected points. The final oral exam is optional and applies only to students who are not satisfied with the proposed final grade. The final oral exam consists of questions related to the theoretical content of the course. Students who collect more than 20 and less than 60 points during semester have to take makeup exam. If they collected 20 or more points on one of the partial exams they need to retake the partial exam that they didn't pass. These makeup exams are similar to the partial ones. If they failed on both partial exams they have to take total makeup exam. This exam consists of four theoretical questions and four problems. Exams cover subjects that are discussed on lectures and tutorials. The exams tests analytical and critical thinking and general understanding of the course subjects. Students can score a maximum of 80 points on this exam and to pass it they need to have at least 40 points. This exam lasts 150 minutes. Students who collect less than 20 points in total after the first term for makeup exams must retake the course next academic year.	
Prerequisites		

Module title	Fundamentals of Computing	
Module code	ETF OR I-1170	
Programme	ETF-B ACE, PE, CI, TC	
Module coordinator	Dr Haris Šupić, Associate Professor	
Teaching staff	Dr Haris Šupić, Associate Professor Vedran Ljubović, MSc, Senior Teaching Assistant Teo Eterović, MoE, Teaching Assistant Alvin Abdagić, MoE, Teaching Assistant Dario Raca, MoE, Teaching Assistant	
Year of study	1	
Semester	1	
Module type	Mandatory	
ECTS	6	
Lectures	44	
Laboratory exercises	26	
Tutorials	0	
Workload – Independent Study	80	
Module outcomes		
	A student who successfully completes the course will have the ability to: • understand fundamental concepts in computing and informatics involving: number systems, basics of computer architecture, and information technology applications; • conceptually understand problem solving strategies using algorithmic approach; • understand the basic terminology used in computer programming; • design simple programs in C language involving: program control statements, arrays, structures, functions, pointers, and input-output operations; • write, compile and debug simple programs in C language.	
Module content		
	1. Introduction: Problem analysis, problem solving methods, algorithms, flow diagrams, program development, top-down and bottom-up development methodology, programming languages. 2. Number systems, basics of Boolean algebra, basics of microprocessor technology, basics of computer architecture, processor structure and function, bus and registry, RAM and ROM memory, input and output, peripheral memories. 3. Basic survey of computing and informatics: local and global computer networks, human-computer communication, network services, internet, electronic mail; Software: structure and organization of computer programs, system software, operating systems, application software. 4. Programming language C: syntax, data types, local and global variables. 5. Control structures, operators, arrays, pointers, pointer declaration and initialization, strings. 6. Functions, function definitions, function prototype, function arguments, function calls and passing arguments to functions: passing by value and passing by reference, recursive functions. 7. Structures, arrays of structures, accessing array elements, operations on structures. 8. Files, work with files, modular programming in C, library functions,	

	dynamic allocation.	
Literature		
Recommended	1. Notes and slides from lectures (See Faculty WEB Site) 2. Mark Burel, Fundamentals of Computer Architecture, Palgrave Macmillan, 2003. 3. Brian W. Kernighan, Dennis M. Ritchie, C Programming Language, Prentice Hall Inc., 1988. 4. Al Kelley, Ira Pohl, A Book on C, Addison-Wesley, 1998.	
Additional		
Didactic methods		
	Lectures introduce fundamental concepts of computing and programming. In this way students are introduced with different components of the computer, different number systems and its conversions and problem-solving strategies. Besides presentation of the fundamental concepts in computing and programming, lectures also consist of the presentations of appropriate examples illustrating introduced concepts. Laboratory exercises and home assignments include additional examples and problems closely coordinated with the lectures. In this way, the laboratory exercises and home assignments contributes to the development of the student ability to understand basic concepts in computing and programming, and ability to design and implement programs in C programming language to solve simple computing problems.	
Assessment		
	The grading of the course is as follows: • Attending lectures and laboratory exercises (maximum 10 points). Student with more than three absences from lectures and/or laboratory exercises cannot get these points. • 5 home assignments equally distributed throughout the semester (maximum 10 points) • Two partial exams: - First partial exam (maximum 20 points) - Second partial exam (maximum 20 points) The partial exams cover all material presented in the lectures, laboratory work and home assignments. During the partial exams students are tested for understanding of fundamental concepts in computing and programming, and their ability to solve simple programming problems in C programming language. • Final exam (maximum 40 points) Students who passed both partial exams (minimum 10 points) can get access to the final exam. The final exam covers material from the entire semester, including lectures, laboratory exercises and home assignments. Passing the final exam is necessary for passing the course. In order to get positive final grade, students must earn minimum of 55 points including attending, home assignments, two partial exams and final exam. Students who have not passed only the second partial exam must repeat only this exam. Students who have not passed both partial exams must pass integral exam covering material from entire semester.	
Prerequisites		

Module title	Electrical Circuits 1	
Module code	ETF EK I-1275	

Programme	ETF-B ACE, PE, CI, TC	
Module coordinator	Dr Narcis Behlilović, Full Professor	
Teaching staff	Dr Narcis Behlilović, Full Professor Dr Irfan Turković, Assistant Professor Dr Senad Smaka, Assistant Professor Mirza Milišić, MSc, Senior Teaching Assistant Mirza Hamza, MSc, Senior Teaching Assistant Irma Sokolović, MSc, Senior Teaching Assistant Mirza Ćosović, Teaching Assistant Lejla Ahmethodžić, Teaching Assistant	
Year of study	1	
Semester	2	
Module type	Mandatory	
ECTS	7	
Lectures	45	
Laboratory exercises	20	
Tutorials	10	
Workload – Independent Study	100	
Module outcomes		
	Module has a goal to provide basic knowledge about criteria for designing and energetic behavior of simple electrical circuits with constant concentrated parameters in conditions where they are powered by single-phase and three-phase voltage source of periodic signals.	
Module content		
	1. Introduction: Electrical circuits with concentrated parameters as models which describe electromagnetic phenomenon. Linear electrical circuit example of linear system. Basic electrical values: voltage, current, power. Kirchhoff's principles and Tellegen's theorem. 2. Two-poles: Resistor, current and voltage source, short-circuit and open-circuit. Thevenin's and Norton's model of passive two-poles. Serial and parallel connection. 3. Basic dynamic circuits: Inductor and capacitor: energy and initial state. 1st order circuits (RC and RL) powered by a DC voltage source. 4. Circuits in stationary sinusoidal regime: Periodical signals and effective value. Relations between sinusoidal signals and phasors. Phasor representation of Kirchhoff's principles. Impedance, admittance, reactance and susceptance of two-poles in sinusoidal regime. Analyses of dynamical circuits in sinusoidal regime (RC, RL and RLC). Active, reactive and apparent power. Maximal transmission power theorem. 5. Electrical network graphs and matrix interpretation: Model of network graph, incidence matrix, electrical values matrix. Kirchhoff's principles, node voltage method, contour current method, Tellegen's theorem, substitution theorem, superposition theorem, reciprocity theorem, Thevenin's theorem, Norton's theorem. 6. Four-poles: Four-pole representation methods. Four-pole power. Symmetry and reciprocity. Four-pole connections. Dependent sources.	

	7. Three-phase systems, triangle and star connections, symmetrical and non-symmetrical regime. Three-phase rotating field and operation principles of electrical motors. 8. *Magnetically coupled circuits*: Self inductance and mutual inductance. Energy in coupled coils. Linear transformer.	
Literature		
Recommended	1. Notes and slides from lectures (See Faculty WEB Site) 2. N. Behlilović, M. Hajro, S. Smaka, Električni krugovi 1, Univerzitet u Sarajevu, , ISBN 978-9958-629-32-7, COBISS.BH-ID 18036742, Sarajevo 2011.	
Additional	1. S. Milojković, Teorija električnih kola, Svjetlost, Sarajevo 1987. 2. D. E. Scott, An introduction to Circuit Analysis-A system Approach, McGraw-Hill, 1976. 3. C. A. Desoer, E. S. Kuhn, Basic Circuit Theory, McGraw-Hill, 1976.	
Didactic methods		
	Lectures are presented directly in lecture-hall and are being supported with typical problems solving (45 hrs) in such manner for students to comprehend and adopt knowledge and skills defined in module outcomes. Throughout laboratory exercises (10 hrs), under guidance of tutor, experiments are carried out in laboratory. Goal of laboratory exercises is for students to master basic skills related to the connection of simple electrical circuits powered by AC voltage sources. Throughout tutorials (20 hrs), under guidance of tutor, typical problems are solved (from topics treated in lectures), including problems from previous exams. In this manner students will be prepared for final exam.	
Assessment		
	The contributions of all activities are rated according to the following scale: • Regular attendance (max. 10 points) • Homeworks / Laboratory exercises (max. 10 points) • 1st midterm exam (max. 20 points) • 2nd midterm exam (max. 20 points) • Final exam (max. 40 points) Regular attendance means that student must be present on all forms of the module's delivery. Student earns 10 x (Number of presence hours) / 60 points for attendance. By solving of homework and/or laboratory exercises (HW/LE), student can earn up to 10 points. Homework is done in the form of preparation and implementation of laboratory exercises under the guidance of assistant (2x2 points) and two short tests (2x3 points). Midterm exams: There are two midterm exams, and both are in written form. At each midterm exam student can earn a maximum of 20 points. Midterm exam is considered to be passed by a student if he earned at least 10 points. First midterm exam is in the 8th week, and second midterm exam is in the 16th week of the semester. Students who failed first and/or second midterm exam are allowed to go through the makeup exam at the end of the semester. Duration of midterm and makeup exams is from 90 to 120 minutes. During midterm and makeup exams students solve the problems that are of the same type as those solved during the lectures and tutorials. Final exam: At final exam, a student can earn a maximum of 40 points. Student will be allowed to take final exam if he/she meets all of the following conditions: • if student passes both midterm exams,	

	• if student earns at least 40 points through: regular attendance, and homework/laboratory, and midterm exams. Final exam is considered to be passed if a student earns a minimum of 15 points. Otherwise, student must take makeup final exam (which is just as structured as the final exam.). Final exam can be written or oral and most frequently is in oral form. At final exam students get three questions related to course topics. Makeup exams and makeup final exam: Students who fail the midterm exam(s) must take the makeup exam. Also, students who fail to earn 40 points (through: regular attendance, and homework/laboratory, and midterm exams), regardless of whether they have passed the midterm exams or not, must take makeup exam. Students who failed final exam must take makeup final exam. Also, students will be allowed to take makeup final exam if they meet all of the following conditions: • if student passes makeup exam, • if student earns at least 40 points through: regular attendance, and homework/laboratory, and midterm exams. Students who fail to earn at least 20 points (through: regular attendance, and homework/laboratory, and midterm exams), regardless of whether they have passed the midterm exams or not, must retake this module next academic year. Also, students who do not achieve a minimum of 15 points at makeup final exam must retake this module next academic year.	
Prerequisites		

Module title	Programming Techniques	
Module code	ETF TP I-1270	
Programme	ETF-B ACE, PE, CI, TC	
Module coordinator	Dr Željko Jurić, Associate Professor	
Teaching staff	Dr Željko Jurić, Associate Professor Enio Kaljić, MoE, Teaching Assistant Darijo Raca, MoE, Teaching Assistant	
Year of study	1	
Semester	2	
Module type	Mandatory	
ECTS	6	
Lectures	44	
Laboratory exercises	26	
Tutorials	0	
Workload – Independent Study	80	
Module outcomes		
	The student that completes the course successfully will get the following competences:	

	• Knowledge about common programming techniques. • Understanding of different approaches to solving programming problems (imperative, object based and object oriented approach). • Ability of analyzing of the stated problem and judgement about what approach is the best one for its solving. • Ability of solving the analyzed problem and its implementation in some programming language derived from programming language C (C++, Java, C#, etc.).	
Module content		
	1. Basic imperative programming in C++: Basic elements of C++ language; Input and output stream; Standard C++ libraries; Types in C++; Logical and enumerated data types; Vectors, deques and strings; Exceptions; References; Default function parameters; Function overloading; Generic functions and templates; Concepts and models. 2. Advanced imperative programming in C++: Dynamic memory allocation; Dynamic variables; Memory leaks; Dynamic arrays; Exceptions during dynamic memory allocation; Complex pointer types (pointers to arrays, arrays of pointers, pointers to pointers); Application of complex pointer types to the dynamic allocation of multidimensional arrays; Indirect data access; Pointers to functions; Standard library algorithms; Blocks and iterators; Usage of standard algorithms for sorting and searching; Structs; Pointers to structs; Dynamic allocation of structs; Arrays and vectors of pointers to structs; Generic structs; Structs with pointer data members; Shallow copying; Nodes; Linked lists. 3. Object based programming in C++: Limitations of structs for data modeling; Object based philosophy; Classes and class instances (objects); Methods and member functions; Information hiding; Encapsulation; Class interface; Friend functions and classes; Constructors; Destructors; Interaction between destructors and shallow copies; Deep copying; Copy constructor; Overloaded assignment operator; Techniques for memory management; Generic classes; Operator overloading; Function objects (functors); Standard library functors; Binders and adaptors. 4. Object oriented programming in C++: Inheritance; Base and derived classes; Object slicing; Inheritance and pointers; Static and dynamic types; Virtual member functions; Polymorhism; Heterogenic container objects; Type identification; Class hierarchies; Pure member functions; Abstract base classes; Polymorphic copying; Files; Serialization of container classes 5. Example of object oriented design; Arithmetical expression trees; Why object oriented approach is necessary; Problem of memory management; Handle classes; Expanding of the functionality.	
Literature		
Recommended	1. Ž. Jurić: "Principi programiranja (kroz programski jezik C++)", ETF Sarajevo, in preparation, working version available 2. J. Šribar, B. Motik: "Demistificirani C++ (2nd edition)", Element, Zagreb, 2003. 3. B. Eckel: "Misliti na jeziku C++, Prvi tom: Uvod u standardni C++ (translation of 2nd edition)", Prentice Hall Inc, translated by Mikro Knjiga, Beograd, 2003.	
Additional	1. L. Kraus: "Programski jezik C++ (sa rešenim zadacima)", Elektrotehnički fakultet Univerziteta u Beogradu, 1997. 2. S. Oualline: "Kako ne treba programirati na jeziku C++ (translation)", translated by Mikro Knjiga, Beograd, 2003. 3. B. Stroustrup: "The C++ Programming Language (2nd Edition)", Addison-	

	Wesley, Reading, MA, 1991. 4. M. Harmann, R. Jones: "First Course in C++: A Gentle Introduction", Univ. of North London, McGraw-Hill Companies, 1997.	
Didactic methods		
	The lectures cover various programming techniques and approaches to the solving programming problems through the programming language C++. Students are also prepared for studying the literature independently. The lectures include simpler examples that illustrate covered theoretical concepts. On the lab exercises, various simpler to moderately hard problems are analyzed and solved that are related to the topics covered on the lectures, also in the programming language C++. Harder problems and case studies are covered through homeworks.	
Assessment		
	The valuation of the student success is as follows: • Active participation in lectures and laboratory exercises (presence, discussion, testing of factual knowledge), 10 points. On the beginning of each lab exercise, the student get a short 5-minute quiz that checks whether the student is prepared for the exercise or not. The student which did not pass the quiz can not access the exercise. The student that have 4 or more absences will not get these points. • I partial written exam, 20 points, 4-7 easy to moderately difficult programmings tasks, exam duration 2 hours • II partial written exam, 20 points, 1-3 moderately difficult programming tasks, exam duration 2 hours • Homeworks, 20 points, 25-35 moderately difficult to hard programming tasks, divided in 6-9 blocks (in average every 10 days), the time limit for solving one block is 8 days • Final oral examination, checking of factual knowledge and understanding of the theoretical concepts, exam duration 20 min. Only students that pass both partial exams may approach to the final examination. For the overall pass, the student must pass the oral exam and must achieve at least 55 points in summary.	
Prerequisites		
	Fundamentals of Computing	

Module title	Electronic Elements and Circuits	
Module code	ETF EES I-1260	
Programme	ETF-B ACE, PE, TC, CI	
Module coordinator	Dr Jasna Pašić, Associate Professor	
Teaching staff	Dr Jasna Pašić, Associate Professor Senad Huseinbegović, MSc, Senior Teaching Assistant Emir Sokić, MSc, Senior Teaching Assistant Almir Salihbegović, Teaching Assistant Adnan Ahmethodžić, Teaching Assistant Mediha Zukić, MoE, Teaching Assistant Aida Branković, MoE, Teaching Assistant	
Year of study	1	
Semester	2	
Module type	Mandatory	
ECTS	5	
Lectures	39	

Laboratory exercises	0	
Tutorials	21	
Workload – Independent Study	65	
Module outcomes		
	The module gives to students understanding of processes in semiconductors and principles of electronic semiconductor components. Students become familiar width basic electronic components: diodes, bipolar transistors, unipolar transistors and thiristors, their symbols, characteristics and mathematical models. Students are able to calculate transfer characteristics of diodes circuits, working points of transistor amplifiers in common emitter and common source connection. Students know technology of integrated circuits and degree of integration (Small scale, Medium scale and Large scale). Students understand principles of functioning of optoelectronic components.	
Module content		
	1. Electric properties of material: Energy zones in solid bodies. Basics of the zone theory. Structure of solid bodies. Semiconductors, conductors, insulators. 2. Properties of semiconductors: Electrons and holes. Donors and acceptors. Density of charge inside semiconductors. Electric properties of semiconductors. Thermistors. Posistors. 3. Properties of the p-n junction (diode): Open p-n circuit. Step potential barrier. Linear potential barrier. Directly polarized p-n circuit. Inversely polarized p-n circuit. Static properties of diodes. Dynamic properties of diodes. Capacitance of reverse bias p-n junction. Break of reverse bias p-n junction. Varicap diode. Zener diode. Tunnel diode. Schottky diode. Application of diode linear model. Diode circuits. Transfer characteristics. Limiters. Non-controllable rectifiers. Single-phase half -wave rectifier. Single-phase full-wave rectifiers. 4. Bipolar transistors: Principles of transistor functioning. Currents through transistor. Simplified model of transistor. Common emitter circuit. Regions' of transistor operation. Amplifiers. 5. Thiristors. 6. Field effect transistors. Principles of FET functioning. Metal-oxide-semiconductor FET (MOSFET, CMOS). JFET. Amplifiers width all kind of Field effect transistors. IGBT. VMOS transistors. Integrated circuits SSI, MSI, LSI. 7. Sending and receiving of optical signals: Receivers of optical signals: photo resistor, photo diode, photo-transistors. Optocuplers. Led diode, Lasers.	
Literature		
Recommended	1. J. Pasic: Elektronički elementi i sklopovi - Knjiga 1, Elektrotehnički fakultet Univerziteta u Sarajevu, Sarajevo, 2012 2. Notes and slides from lectures (See Faculty WEB Site)	
Additional	1. Thomas L. Floyd, 'Electronics Devices', Prentice Hall 2012. 2. Richard C. Jaeger: Microelectronics Circuit Design, McGraw Hill, 1997 3. P. Biljanović: Poluvodički elektronički elementi, Školska knjiga, Zagreb, 1996 4. O.Musić, N. Hadžimejlić, M.Musić: Elektronika 1. Elektrotehnički fakultet Univerziteta u Sarajevu, Sarajevo, 2011 5. Dragoljub Milatović, Osnovi elektronike, Svjetlost, Sarajevo, 1991.	
Didactic methods		
	Lectures are performed directly in classroom for all students. Theoretical explanations, important for the course, are illustrated by solving of numerical	

	problems performed by professor, what is done in classroom also. On the lectures students are getting problems for independent work (assignments) in order to overcome course program. Tutorials are organized in groups of maximum 25 students, where, with tutor assistance, they analyzed problems from exercises and solve new problems.	
Assessment		
	During the module student earns points according to the following system: - Attending classes and tutorials: 10 points. - Home assignments: maximum of 10 points: solving 4 home assignments equally distributed throughout the semester (2 points). After each home assignment student has a small test (2x4 points, total 8 points). - Partial exams: two partial exams; each positively evaluated partial exam earns 10 to 20 points. Each partial exam lasts 90 minutes and it is structured as follows: - Simple questions (5) with goal of testing whether student has basic theoretical knowledge; correct answer to each question earns 1 points (total 5 points); - Multiple choice questions (5); student with correct answers to each question earns 1 point (total 5 points). No correct answer brings no negative points; - Two numerical problems; correct answers earn 5+5 (10) points. Oral repeat exam provides maximum of 40 points.	
Prerequisites		
	Mathematics for Engineers 1, Fundamentals of Electrical Engineering	

Module title	Mathematics for Engineers 3	
Module code	ETF AEO IM3 I-2370	
Programme	ETF-B ACE	
Module coordinator	Dr Alma Omerspahić, Associate Professor	
Teaching staff	Dr Alma Omerspahić, Associate Professor Alvin Abdagić, MoE, Teaching Assistant	
Year of study	2	
Semester	3	
Module type	Mandatory	
ECTS	5	
Lectures	50	
Laboratory exercises	0	
Tutorials	30	
Workload – Independent Study	45	
Module outcomes		
	Upon successful completion of this course, students should know and comprehend the concepts and be able to apply methods in the area of complex analysis and integral and other transforms necessary for examination of problems in control theory. In particular, students should be able to: Calculate and manipulate expressions that involve complex functions. Determine the limit of a complex function, examine its continuity and differentiability, calculate derivatives, check for analyticity and find an analytic function under some conditions, find the Laurent expansion, determine and classify singularities, compute residues. Map a given region with a complex function. Apply the Cauchy's residue theorem for evaluation of complex integrals. Use complex integration to: evaluate certain definite and improper integrals, find	

	the inverse Laplace transform, determine Fourier series and the Fourier transform. Find the Z-transform along with its region of convergence. Apply the Z-transform to solve recurrence equations and systems of recurrence relations, sum certain numeric series.	
Module content		
	1. Functions of a Complex Variable. Limits and Continuity. Differentiability. The Cauchy-Riemann Equations. Analyticity. 2. Complex Integration. The Cauchy-Goursat Theorem. The Cauchy's Integral Formula. 3. Series of complex functions. Taylor and Laurent series. Singularities and their Classification. Residue Calculus. The Cauchy's Residue Theorem. 4. Evaluation of Certain Definite and Improper Integrals. 5. The Inverse Laplace Transform. The Mellin's inverse formula. 6. Conformal mappings. Mobius Transformations. 7. Fourier Trigonometric Series, The Fourier Transform and Integral. Properties. Complex Form. 8. The Discrete Laplace Transform. 9. The Z-transform. The Inverse Z-transform. Properties. Recurrence Equations. Application of the Z-transform. The Modified Z-transform.	
Literature		
Recommended	1. Lecture notes (available at the courseware). 2. E. B. Saff, A. D. Snider, *Fundamentals of Complex Analysis with Applications for Engineering and Science*, Pearson, 2003 3. D. S. Mitrinović, *Kompleksna analiza*, Građevinska knjiga, 1967	
Additional	1. I. Ivanšić, *Funkcije kompleksne varijable. Laplaceova transformacija*, Liber, 1978 2. I. Ivanšić, *Fourierov red i integral. Diferencijalne jednadžbe*, Liber, 1979 3. J. Bak, D. J. Newman, *Complex Analysis*, Springer, 2010 4. J. W. Brown, R. V. Churchill, *Complex Variables And Applications*, McGraw-Hill, 2008 5. J. G. Krzyż, *Problems in complex variable theory*, Elsevier, 1971	
Didactic methods		
	This course is thought through two types of activities: lectures and tutorials. During the lectures, along with interpretation of important mathematical concepts, selected example problems will be solved to further explain the theoretical concepts covered. During the tutorials, students with the help of a teaching assistant will solve problems from previous homework assignments and exams and other illustrative examples. With each tutorial, students are given problems for individual practice, some of which are part of obligatory homework assignment.	
Assessment		
	The final grade is accumulated as follows: - Attendance to all classes, both lectures and tutorials: up to 10 points; *Student that is absent more than three times from lectures/tutorials cannot score points on this account.* - Homework assignments: up to 10 points; *Up to 10 homework assignments evenly distributed during the course of semester.* - Midterm exams: two written midterm exams each graded with up to 20 points; *It is considered that a student has passed an exam when she/he has scored at least 10 points.* - Final exam graded with up to 40 points.	

	A student must have passed both midterm exams to be eligible for the final exam. In order to achieve a passing final grade, a student must pass the final exam (achieve at least 20 points) and have accumulated at least 55 points through all means of assessment.	
Prerequisites		
	Mathematics for Engineers 1, Mathematics for Engineers 2	

Module title	Electrical Circuits 2	
Module code	ETF AIO EK2 I-2365	
Programme	ETF-B ACE, PE, TC	
Module coordinator	Dr Smajo Bišanović, Assistant Professor	
Teaching staff	Dr Smajo Bišanović, Assistant Professor Mirsad Ćosović, MoE, Assistant	
Year of study	2	
Semester	3	
Module type	Mandatory	
ECTS	6	
Lectures	42	
Laboratory exercises	0	
Tutorials	23	
Workload – Independent Study	85	
Module outcomes		
	This course is one of the basic disciplines in electrical engineering – beside classical application in solving electrical circuits, this course provides review of many principles that are used in electrical engineering, electronics, telecommunications and signal processing, control systems. Acquired knowledge and skills is a powerful tool for solving many problems in theory and practice, as well as a assistance and the basis for further study the behavior of electrical circuits and systems. Students become able to present many engineering problems with model of electrical circuits and the mathematical analysis of such model relate to the physical essence of the process in an electrical circuit. Selected topics in this course provide a satisfactory compromise between the abundance of matter, especially matter that is in many ways more attractive for the study, and the necessary minimum as a traditional approach to the study that cannot be avoided. In this course the acquired mathematical knowledge and skills, the basic physical postulates in the field of theoretical electrical engineering, and modeling capabilities, choice of techniques solving, and verification of the obtained solutions and conclusions are demonstrated. Therefore, acquired knowledge and skills represent the foundation on which further professional upgrade student is based.	
Module content		
	1. Analysis of first order linear time invariant circuits: solving circuits with known initial values, own response of first order circuits from the stationary state, complete response of first order circuits. 2. Analysis of second order linear time invariant circuits: natural response of RLC circuits, forced response of second order circuits, complete response of second order circuits. 3. Solving response of time invariant circuits using Laplace transform. 4. Oscillating electric circuits. Resonance: simple resonant circuit, resonant	

	circuit with imperfect inductor, resonant circuit with imperfect capacitor. Anti-resonance: simple anti-resonant circuit, anti-resonant circuit with imperfect capacitor, anti-resonant circuit with imperfect inductor. Complex LC circuits. 5. Solving stationary response of linear time invariant electric circuits to complex-periodic excitation signal using Fourier series. 6. Symmetrical components in balanced and unbalanced three phase systems – matrix interpretation, symmetrical components unsymmetrical phasors, sequence impedances and sequence networks, unsymmetrical faults. 7. Two-port circuits – primary and secondary parameters. 8. Passive electrical filters: low and high frequency filters, band pass and band stop filters, filters with derived cells. 9. Analysis of electric circuits with distributed parameters: transmission lines. 10. Transition process in circuits with distributed parameters.	
Literature		
Recommended	1. Bilješke i slajdovi s predavanja (moći će se preuzeti na web site-u Fakulteta). 2. M. Kušljugić, M. Hajro: "Analiza električnih kola u vremenskom domenu", Univerzitet u Tuzli, 2005. 3. S. Milojković: "Teorija električnih kola", Svjetlost Sarajevo, 1989.	
Additional	4. M. Kušljugić, M. Hajro, "Elementi i metode u analizi električnih kola", Univerzitet u Tuzli, 2005. 5. B. Reljin, "Teorija električnih kola 1 – rešavanje kola u vremenskom domenu", Akademska misao, Beograd, 2002. 6. B. Reljin, "Teorija električnih kola 2 – rešavanje kola u frekvencijskom domenu", Akademska misao, Beograd, 2002.	
Didactic methods		
	Module content delivery is performed through three activities: Lectures in a lecture hall for all students, presented by lecturer, during which theoretical – fundamentals aspects of the electrical circuits are presented followed by stating and solving numerical problems. Tutorials during which other problems are solved under guidance of the tutor, and this include solving problems from previous exams with goal of achieving better understanding of presented theoretic topics and understanding of concepts for with basic knowledge about all aspects of electrical circuits and their components. Laboratory exercises for experimental and virtual demonstration of theoretic concepts presented during lectures.	
Assessment		
	During the course students earn points according to the following system: • attending classes and tutorials: 10 points, student with more than three absences from lectures and/or tutorials cannot get these points; • homework and laboratory exercise: maximum of 10 points; assuming solving 6 homework with each positively evaluated assignment bringing 1 point, and laboratory exercise 2 points; • partial written exams: two partial exams, each positively evaluated partial exam bringing maximum 20 points. Partial written exam is structured in the following manner: • answers to simple questions with goal of testing whether student has knowledge of basic theoretic knowledge – each answer bringing 5 points; • solving one numerical problem with complete solving procedure – bringing up to 10 points; • solving numerical problem with several offered answers with correct answer - bringing 5 points (incorrect answers bringing negative points). Students who earned 40 or more points during the semester will take a final	

	exam; based on the opinions of professors and tutors final exam can be achieved and the student with up to 10% fewer points; the exam consists of discussion of problems from partial exams, home assignments and answers to simple questions related to course topics. Final oral exam provides maximum of 40 points. In order to get positive final grade, students must earn minimum of 20 points in this exam. Student failing to earn the minimum must take the makeup oral exam. Student who earned 20 or more, and less than 40 points during the semester will have to take the makeup exam. The makeup exam – written and oral is organized in the same manner as regular exam. Oral exam will be allowed to take student who in any partial exam earn 10 points or more, or who managed to earn total score of 40 or more points in written part (regular/makeup exam): the score consists of points earned through attending classes, homework, taking partial exams and / or pass the written part of the makeup exam. Students who gained less than 20 points during the semester must repeat that course.	
Prerequisites		
	Mathematics for Engineers 1, Mathematics for Engineers 2, Electrical Circuits 1	

Module title	Electrical Measurement	
Module code	ETF AEO EM I-2360	
Programe	ETF-B, ACE, PE, TC	
Module coordinator	Dr Alija Muharemović, Full Professor	
Teaching staff	Dr Alija Muharemović, Full Professor Adnan Mujezinović, MoE, Assistant	
Year of study	2	
Semester	3	
Module type	Mandatory	
ECTS	5	
Lectures	35	
Laboratory exercises	20	
Tutorials	5	
Workload – Independent Study	60	
Module outcomes		
	After completing the course, students should be able to: • determine the errors of measuring instruments, that is statistically process measurement results and corresponding measurement uncertainty, • properly use all types of analog measuring instruments especially taking into account their characteristics, • solve calculation problems in measuring electrical values from the aspect of making smaller systematic errors, • compare and analyze the use of different methods of measuring all electrical values, • properly connect and select the appropriate sensors, design circuits with connection of sensors and computer equipment.	
Module content		
	1. **Fundamentals of metrology:** European and international metrology- test organization, internationally recognized systems of authorization and confirmation and structure of the system quality. Errors of measuring instruments, statistical processing of the measurement results, the parameters of probability of measurement results. Procedures of ensuring	

	international Traceability (consistency) and associated measurement uncertainty. Statistical analysis of the results of measurement and calculation of measurement uncertainty in testing. Traceability of measurement in testing. **2. Analog measuring instruments:** Composition, operating principle and characteristics of instruments with movable coil; with cross coils; with movable iron; electro dynamic instruments and electrostatic instruments. **3. Digital Measuring Instruments (composition, operating principle, characteristics):** conversion of analog data into digital. Binary counters. Converting the voltage in the time. Digital voltmeter. Multimeters. **4. Etalons of electrical values and laboratory sources:** A hierarchical series of etalons. Calibration of etalons. Etalons of electrical values. Laboratory sources of direct and alternating current. **5. Measurement of electrical power and energy:** Energy meters. Inspection and certification of the meters. Ways to connect the meters to the electric network. Methods of measurement of electrical power. Power measurement in DC circuit. Power measurement in AC circuit. **6. Measuring Bridges:** Witstons bridge. Witstons unbalanced bridge. Compensators. Measuring bridges of alternating current. The descriptions of the measuring bridges (Vins, Maxvels, etc). **7. Sensors:** Classification of sensors. Technical characteristics of sensors (static, dynamic). Resistive, capacitive, inductive, electromagnetic, piezoelectric and thermoelectric sensors. **8. Methods of measuring electrical values:** Measurement of electrical resistance. Measurement of transient grounding resistance. Measuring the soil resistivity. Measurement of voltage and current. **9. Computer based measurement:** The role of computers in the measuring process. Programmable measuring instruments. Automated measuring systems. Design and create of automated measuring systems. Collection and transmission of measurement data. **10. Introduction to Labveiw software and interfaces:** Virtual instrument. Interfaces. Standard interfaces. Interfaces standard developed for automated measurement.	
Literature		
Recommended	1. A. Muharemović, Electrical measurement, Slides and lecture notes, Sarajevo, 2013, http://www.etf.unsa.ba/ 2. D. Vujević, B. Ferković, „Basics of electrical measurement“, FER Zagreb, Zagreb, 2001. 3. A. Muharemović: "Electrical measurement", ETF Sarajevo, 2005 (Book). 4. A. Muharemović, I. Turković: “Electrical measurement – book of tasks”, ETF Sarajevo, 1997.	
Additional	1. A. Šantić: “Electronical instrumentation”, Školska knjiga Zagreb, 1988. 2. Alan S. Morris, “The essence of Measurement”, Prentice Hall London, 1996. 3. F. K. Petrović: “Electrical measurement” Naučna knjiga, Beograd, 1992.	
Didactic methods		
	The lectures consist of carefully prepared presentations. The lectures provide the students with a focus on the core material in the course. The lecture explains the basic problems related to measuring instruments and methods of measurement. All this is illustrated on practical examples. In addition, the students knowledge shall be deepened by solving exercises - the applied method of teaching is to deliver lectures and to assist in solving exercises during the tutorial sessions. On tutorials students should gain the necessary analytical skills and develop critical way of thinking. Students are invited to take advantage of the tutorials for questiones related to any problem they encountered during the tracking course. During the laboratory exercises students acquire the skills needed to perform basic measurements of electrical quantities in the measuring laboratories	

	under the supervision of the assistant.	
Assessment		
	During the course students earn points according to the following system: - attending classes and tutorials - 10 points; - homework - maximum of 10 points (a student is supposed to make 5 homework, and each positively evaluated task brings 2 points); - two partial exams - maximum of 20 points; - final exam - maximum of 40 points.	
Prerequisites		
	Fundamentals of Electrical Engineering, Electrical Circuits 1	

Module title	Analogue Electronics	
Module code	ETF AEO AE I-2360	
Programme	ETF-B ACE	
Module coordinator	Dr Abdulah Akšamović, Associate Professor	
Teaching staff	Dr Abdulah Akšamović, Associate Professor Mediha Zukić, MoE, Teaching Assistant	
Year of study	2	
Semester	3	
Module type	Mandatory	
ECTS	5	
Lectures	36	
Laboratory exercises	24	
Tutorials	0	
Workload – Independent Study	65	
Module outcomes		
	Upon successful completion of this course, students should be able to: • Analyze functionality and calculate the electrical quantities of circuits consisting of bipolar and field-effect transistors and operational amplifiers operating in linear regions. • Understand the principles of constructing more complex circuits based on previously mentioned semiconductor components. • Choose an appropriate electronic circuit for a specific problem and perform the necessary calculations to determine the exact values of all components.	
Module content		
	1. **Bipolar junction transistors (BJT):** Structure. Principles of operation. Characteristics and parameters. Amplifiers with BJT. BJT as a switch. Phototransistors. Quiescent point. Load line. Biasing. 2. **AC signal amplifier with BJT:** Principles of amplifier operation. Small-signal model of BJT. Two-port parameters of BJT. Common-emitter, common-base and common-collector topologies. Differential amplifier. Multistage amplifiers. Feedback. Positive feedback. Negative feedback. Voltage feedback. Current feedback. 3. **Power amplifiers:** Class A amplifiers. Class B amplifiers. Class AB amplifiers. 4. **Filed-effect transistors (FET):** Principles of JFET operation. JFET characteristics and parameters. Quiescent point of JFET. MOSFET. Load line of MOSFET. FET as a switch. 5. **AC signal amplifiers with FET:** Common-source, common-gate and	

	common-drain topologies. **6. Amplifier frequency response:** Basics. Decibel. Low-frequency amplifiers. High-frequency amplifiers. Frequency response of multistage amplifiers. **7. Operational amplifier (Op amp):** Principles of operation. Model and parameters. Feedback. Offset current and offset voltage. Open-loop and closed-loop gains. Frequency response of open-loop amplifier and amplifier with feedback. **8. Op amp circuits:** Inverting and non-inverting amplifiers. Summing amplifier. Inverting integrator and differentiator. Voltage follower. Instrumentation amplifier. Logarithmic and anti-logarithmic amplifier. **9. Active filters:** Basics. Frequency response of a filter. Low-pass filer. High-pass filter. Band-pass and band-stop filters. Measurement of frequency response. **10. Oscillators:** Principles of operation. Feedback oscillator. RC oscillator circuit. LC oscillator circuit. NE555 timers. **11. Voltage regulators.** Basics. Linear series voltage regulator. Linear shunt voltage regulators. Integrated circuit voltage regulators. 12. **Labs:** 1. Amplifier AC load line (BJT and MOSFET). 2. Single-stage BJT and MOSFET amplifier. 3. Two-stage BJT and MOSFET amplifier. 4. AB class power amplifier. 5. Frequency response of single-stage amplifier with and without feedback. 6. Frequency response of two-stage amplifier. 7. Basic op-amp circuits: inverting and non-inverting amplifier, voltage follower. 8. Basic op-amp circuits: Summing amplifier, differentiator, integrator. 9. Op-amp frequency response. 10. Active filters with op-amps: low-pass, high-pass, band-pass, band-stop. 11. Oscillators with NE555. 12. Linear voltage regulators.	
Literature		
Recommended	1. P. Biljanović, *Elektronički sklopovi*, Školska knjiga, Zagreb, 1989 2. A. Akšamović, M.Hebibović, *Elektronika s aspektom primjene u regulaciji*, Sarajevo, 2010	
Additional	1. Thomas L. Floyd, *Electronics Devices*, Prentice Hall, 2012 2. Sergio Franco, 'Design with operational amplifiers and analog integrated circuits', Mc Graw Hill, 2002.	
Didactic methods		
	This course is thought through lectures in aula, organized for all students (36 classes in total). Along with the explanation of theoretical concepts from the module content, selected example problems, with actual numerical quantities, will be solved to illustrate all the theoretical phenomena covered. During the labs, students will realize circuits with actual components. As a part of preparation for labs, students will do necessary calculations and perform simulations. The obtained results, along with work done as the preparation for the labs and comparisons of results obtained though calculations, simulation and with actual circuits are submitted.	
Assessment		
	Through the duration of the course, points are accumulated as follows: • attendance to all classes: up to 10 points; • preparation for the labs, work and reports: up to 10 points; • two partial exams: up to 20 points each (40 in total); • oral exam: up to 40 points.	
Prerequisites		
	Electrical Circuits 1, Electronic Elements and Circuits, Mathematics for Engineers 1	

Module title	Sensors and Measurements	

Module code	ETF AEO SIM I-2360	
Programme	ETF-B ACE	
Module coordinator	Dr Irfan Turković, Assistant Professor	
Teaching staff	Dr Irfan Turković, Assistant Professor Lejla Ahmethodžić, Assistant	
Year of study	2	
Semester	3	
Module type	Mandatory	
ECTS	5	
Lectures	36	
Laboratory exercises	18	
Tutorials	6	
Workload – Independent Study	65	
Module outcomes		
	Upon completing the course, students should be able to explain the principle of operations of several types of sensors, point their limitations, and adequately choose a sensor for their need. In addition, the procedure for testing the accuracy of the sensors, as well as procedure of the measurement results presentation according to international standards will be introduced to the students. Knowledge gained in this course will be useful to students in the area of technical processing of sensor signals, its transfer and usage in measurement systems and automatic control systems.	
Module content		
	1. **Introduction to metrology**: Fundamental measurement terms. Physical quantities and their measurement. Modern methods for processing of the measurement results. Uncertainty of measurement. 2. **Technical characteristics of sensors:** Static metrological characteristics (range, accuracy, sensitivity, linearity, hysteresis, stability, input and output impedance). Dynamic characteristics of first and second order sensors (response time, characteristics in frequency domain). Methods for improvement of the dynamic characteristics. 3. **Reliability of measuring devices**: general features and indicators of reliability, quantitative features of reliability, device and system failure, types of failure, mean time to failure, law of exponential distribution, reliability of complex systems (series and parallel configuration of blocks), methods for increase of reliability of measuring devices. 4. **Displacement measurement:** Resistive displacement sensor, inductive displacement sensor, capacitive displacement sensor, inductive differential displacement sensor, LVDT sensor, digital sensor (encoders – absolute and incremental), location sensors, laser displacement sensors, presence and motion detection sensors. 5. **Velocity measurement:** Velocity measurement using displacement sensors, DC and AC tachometer generator, sensors based on eddy currents, optoelectronic sensors, reluctance and inductive sensors, capacitive sensors, sensors based on Doppler's effect. Methods for angular velocity measurement. 6. **Acceleration measurement:** Dynamic model of acceleration sensor, seismic accelerometers, servo accelerometers, piezoelectric accelerometers. Vibration measurement. 7. **Force and strain measurement:** Measurement using accelerometers and	

	piezoelectric sensors. Strain gage, principle of operation and design, compensating the temperature effect. Measurement circuits for measurement using strain gages. Sensors based on magnetostriction. 8. **Flow measurement:** Types of fluid flow, measurement of flow based on pressure drop at the restriction in a pipe (Venturi tube, nozzle, and diaphragm), induction flow sensors, rotameter, turbine flow meters, volumetric flow meters, vortex flow meters, ultrasonic flow meters, and anemometers. 9. **Pressure measurement:** Manometers with fluids, deformation manometers, Burdon's tube, manometers with membranes, pressure measurement using strain gages, measuring low absolute pressures – vacuum meters. 10. **Temperature measurement:** Temperature scales, expansion temperature sensors, resistive thermometers, thermistor, thermo elements, radiation thermometers, semi-conductor sensors, fiber-optic thermometer, quartz thermometer. 11. **Level measurement:** Hydrostatic level sensor, float level sensors, capacitive sensors for conductive and non-conductive liquids, resistive sensors, ultrasonic sensors, ways to mount level sensors.	
Literature		
Recommended	1. I.Turković, Senzori i mjerenja, Slajdovi i bilješke, Sarajevo, 2012, http://www.etf.unsa.ba/ 2. D.Stanković, "Fizičko tehnička merenja" Univerzitet u Beogradu, 1997.god.	
Additional	1. M.Popović, Senzori i mjerenja, Viša tehnička škola Beograd 2000. god. 2. Jacob Fraden, **Handbook of Modern Sensors: Physics, Designs, and Applications**, 3rd, Springer-Verlag, 2004 3. J. J. Carr, Sensors and Circuits, Prentice Hall, New Jersey 1993.	
Didactic methods		
	Course material is presented in following ways: Lectures performed in an aula for all students by the teacher. During those lectures, fundamental theoretical aspects for measurement of physical quantities will be explained. In addition, numerical problems will be solved. In tutorials, under the guidance of the teaching assistant, specific numerical problems are solved. During laboratory exercises, students will learn to measure certain physical quantities. Along the practical measurements, laboratory exercises need to be numerically prepared. As part of the exercises, students will have one or two visits to industrial facilities. The goal of these visits is to show the students the basic features of industrial measurement, how to install the equipment, its use and maintenance.	
Assessment		
	During the course, students earn points according to the following system: • Attendance to lectures and tutorials: 10 points. • Laboratory exercises – students will have 9 laboratory exercises during the course, worth maximum of 20 points. • Two written exams, midterm and final, each written exam with a maximum of 20 points. • Final oral exam, worth up to 30 points.	
Prerequisites		
	Fundamentals of Electrical Engineering, Physics for Engineers 1, Physics for Engineers 2	

Module title	Discrete Mathematics	
Module code	ETF RIO DM I-2360	
Programme	ETF-B CI, ACE	
Module	Dr Željko Jurić, Associate Professor	

coordinator		
Teaching staff	Dr Željko Jurić, Associate Professor Razija Turčinhodžić, MSc, Senior Teaching Assistant Harun Šiljak, MoE, Teaching Assistant	
Year of study	2	
Semester	3	
Module type	Elective	
ECTS	5	
Lectures	39	
Laboratory exercises	0	
Tutorials	21	
Workload – Independent Study	65	
Module outcomes		
	The student that completes the course successfully will get the following competences: • Ability of identification of problems from computer science with background in mathematical logic, set theory, number theory, combinatorics, probability theory, graph theory, theory of discrete systems and computability theory. • Ability of analyzing and solving problems from the branches mentioned above, after their successful identification. • Ability of evaluation of the quality of obtained solution of the problems mentioned above, and their generalization.	
Module content		
	1. Introduction and motivation: What is discrete mathematics; Continuous (analog) and discrete quantities; Connection between continuous and discrete quantities. 2. Elements of the propositional logic and propositional algebra: Propositions; Laws of the propositional logic; Transformations of propositional expressions; Tautologies and mathematical way of deriving conclusions; Standard forms of logical expressions; Quine's method for deriving minimal Sum of Products and Product of Sums; Sheffer's and Pierce's operations; Bases of the logical algebra. 3. Elements of the set theory: Basic concepts of the set theory; Operations with sets; Laws of the algebra of sets; Ordered *n*-tuples and Cartesian product of sets; Relations; Functions; Equivalence and ordering relations; Natural numbers as sets; Cardinal numbers; Contraverses of naive set theory and axiomatic set theory. 4. Boolean algebra and related topics: Concept and important examples of Boolean algebra; Switching functions; Arithmetization of switching functions; Zhegalkin algebra; Ternary logics; Fuzzy logic. 5. Elements of the predicate logic: Concept of predicate; Quantificators; Free and bound variables; First order predicate logic; Interpretations of the first order predicate logic; Valid expressions and logical consequences; Reducing of predicate expressions to the prenex normal form; Positive test for validity of predicate expressions; Second order predicate logic. 6. Introduction to the elementary number theory; Divisibility and criteria for divisibility; Prime numbers; Greatest common divisor and least common multiplier; Euclid algorithm; Diophantine equations; Euler totient function and Fermat-Euler's theorem; Congruences and modular arithmetics; Linear and quadratic congruences; Some applications of the number theory in	

	cryptography. 7. Introduction to the combinatorics: Basic concepts; Permutations, variations and combinations without and with repetitions; Sample selection problem; Permutations of total disorder (dearrangements); Partitions and compositions. 8. Introduction to the theory of discrete probability; Algebra of events; Concept and calculation of probability; Conditional (relative) probability and independent events; Total probability and Bayes's theorem; Experimental calculation of the probability and statistical interpretation of the meaning of the probability. 9. Elements of the graph theory: Basic concepts and notations; Paths and connectivity of graphs; Methods for the representations of graphs; Graph isomorphism; Operations with graphs; Planar graphs; Eulerian and Hamiltonian paths; Graph coloring; Trees, spanning trees and searching in graphs; Minimal spanning trees; Shortest path problem; Transport networks and maximal flow problem; Matching; Rooted trees and binary trees 10. Introduction to the theory of discrete systems: Discrete signals and systems; Linear time-invariant systems; Discrete convolution; Transfer function; Z-transform; Inverse z-transform; Applications of z-transform. 11. Elements of the computability theory: Concept of the algorithm; Algorithmically unsolvable problems; Turing machine as a model of universal computing machine; Universal register machines; Kleene's concept of recursive functions; Post's rewritting systems; Normal algorithms of Markov; Church's λ-calculus.	
Literature		
Recommended	1. Ž. Jurić: "Diskretna matematika za studente tehničkih nauka", ETF Sarajevo, 2011. 2. D. M. Cvetković, S. K. Simić: "Diskretna matematika – Matematika za kompjuterske nauke", Prosveta, Niš, 1996. 3. K. H. Rosen: "Discrete Mathematics and Its Applications", McGraw Hill Companies, 1998. 4. R. P. Grimaldi: "Discrete and Combinatorial Mathematics (An Applied Introduction)", Addison-Wesley Publishing Company, 1994.	
Additional	1. D. Veljan: "Kombinatorika (s teorijom grafova)", Školska knjiga, Zagreb, 1989. 2. D. M. Cvetković, M. Milić: "Teorija grafova i njene primjene", Naučna knjiga, Beograd, 1990. 3. S. Muftić: "Matematske osnove kompjuterskih nauka", Veselin Masleša, Sarajevo, 1984. 4. R. Johnsonbaugh: "Discrete Mathematics", Pearson Prentice Hall, 2005.	
Didactic methods		
	The lectures covers theoretical concepts from the discrete mathematics. They are illustrated through simpler examples. Also, students are prepared for studying the literature independently. On the tutorials, various simpler and moderate complex problems related to lectures are analysed and solved. Harder problems and case studies are covered through homeworks.	
Exams		
	The valuation of the student success is as follows: • Active participation in lectures and tutorials (presence, discussion), 10 points. The student that have 4 or more absences will not get these points. • I partial written exam, 20 points, 9-11 easy to moderately difficult problem solving tasks, exam duration 2 hours. • II partial written exam, 20 points, 8-9 easy to moderately difficult problem solving tasks, exam duration 2 hours.	

	• Homeworks, 10 points, 40-60 moderately difficult to hard problem solving tasks, divided in 4-7 blocks (in average every 2 weeks), the time limit for solving one block is 7 days • Final oral examination, checking of factual knowledge and understanding of the theoretical concepts, exam duration 20 min. • Only students that pass both partial exams may approach to the final examination. For the overall pass, the student must pass the oral exam and must achieve at least 55 points in summary.	
Prerequisites		
	Mathematics for Engineers 1, Linear Algebra and Geometry	

Module title	Dynamical Systems	
Module code	ETF AEI DS I-2355	
Programme	ETF-B ACE	
Module coordinator	Dr Avdo Voloder, Full Professor	
Teaching staff	Dr Avdo Voloder, Full Professor Mehmed Brkić, MoE, Assistant	
Year of study	2	
Semester	3	
Module type	Elective	
ECTS	4	
Lectures	35	
Laboratory exercises	10	
Tutorials	10	
Workload – Independent study	45	
Module outcomes		
	• Understanding some basics of kinematics and dynamics of mechanical and process systems • Capability of deriving equations for complex dynamical systems • Capability of modeling and simulation of complex dynamical systems using appropriate software environments • Analysis of systems behaviour considering the presence of external and internal forces	
Module content		
	1. Introduction to dynamical systems. Basic structure of mechanical systems. 2. Position and orientation of rigid bodies. Linear transforms. Composition of rotations. Coordinate transform and homogeneous coordinates. 3. Principle of invariance. Rotation of a rigid body with respect to a point. Minimal representation of orientation using Euler angles. 4. Holonomic and nonholonomic systems. Forward and inverse kinematics of mechanical systems. System redundancy. 5. Velocity and acceleration of a rigid body. Computation of linear and angular velocities using Jacobian matrix. 6. Rigid body statistics. Rigid body dynamics. 7. Numerical solutions to the problems of forward and inverse kinematics. Equations of motion. Lagrange and Newton-Euler equations. 8. Linearized equations of motion. Recursive inverse dynamics. 9. Analysis of internal and external disturbances. Friction, gravity, centripetal and Coriolis forces. Modeling of dissipative forces.	

	10. Motion planning of a rigid body. Path and trajectory. Parametric representation of a trajectory in space. Tracking a continuous path. 11. Kinematics and dynamics of multi-body systems. Examples of serial and parallel manipulators. Analysis of systems with wheels. Examples of differential and car-like motions.	
Literature		
Recommended	1. Lectures and slide notes 2. Jorge Angels, Fundamentals of robotic mechanical systems, Springer Verlag, New York, 1997. 3. John R. Taylor, Classical mechanics, University Science Books, Sausalito, 2005.	
Didactic methods		
	• **Lectures.** Lectures are accompanied by illustrative examples in order to help students to understand various tools and methods used in the field of dynamical systems. • **Laboratory exercises.** Students work with various software tools used for dynamical system modelling and simulation. TA helps student to work with examples covered during the course lectures. • **Tutorial.** Students solve various problems including the examples of previous exams. These activities are organized such that the knowledge that students have gained during the lectures are continuously checked through the homework assignments as well as partial exams. This helps students to acquire necessary skills required by the course.	
Assesment		
	During the semester, students collect points according to the following system (max **100** points): - Attendance: max 10 points; - Lab exercise reports and homework assignments: max 30 points; - Partial exams: max 20 points; - Final exam: max 40 points.	
Prerequisities		
	Mathematics for Engineers 1, Mathematics for Engineers 2, Physics for Engineers 1	

Module title	Digital Electronics	
Module code	ETF AEO DE I-2465	
Programme	ETF-B ACE	
Module coordinator	Dr Jasna Pasić, Associated Professor	
Teaching staff	Dr Jasna Pasić, Associated Professor Senad Huseinbegović, MSc, Senior Teaching Assistant	
Year of study	2	
Semester	4	
Module type	Mandatory	
ECTS	5	
Lectures	39	
Laboratory exercises	16	
Tutorials	10	
Workload – Independent Study	60	
Module outcomes		

	After finishing the module students have enough knowledge to make independent design, realization and testing of digital electronic circuits based on discrete semiconductor components and integrated amplifiers, also. Students become familiar width methods and procedures of analysis and design of such circuits. Students are familiar with physical principles of functioning, modeling and analyzing of transient phenomena in switching circuits containing RC and RL components. Students gain knowledge about basic switching circuits and principles of signal convertors design.	
Module content		
	1. RESPONSE OF LINEAR CIRCUITS ON PULSE SIGNAL: Passing of impulses through linear circuits. Methods of impulse circuit analysis. RC and RL circuit responses. RC and RL circuit response to step function. RC and RL circuit response to ramp. RC and RL circuit response to series of rectangular pulses. RC and RL circuit response to trapezoidal input signal. Differentiating circuits. Integrating circuits. 2. SEMICONDUCTOR COMPONENTS AS A SWITCH: Bipolar transistor, unipolar transistor, thiristor and triac as a switches. Qualitative description of switching process, static and dynamic characteristics. 3. CIRCUITS FOR FORMING IMPULSES: Bistable multivibrator, monostable multivibrator, astable (free running) multivibrator. Analysis of behavior of circuits for forming impulses, transient phenomena and calculation procedure. 4. SCHMITT'S CIRCUIT: Hysteresis. Schmitt's circuit with transistors operating in linear mode. Analysis of hysteresis. Schmitt's circuit with transistors working in switching mode. Schmitt's circuit with MOSFET. Instructions for calculation. 5. SAW TOOTH SWEEP GENERATORS: Basic characteristics of saw tooth signal. Circuits for generation of saw tooth voltage with semiconductor components. Saw tooth voltage generator with source of constant current. Procedure of calculation. 6. CIRCUITS FOR FORMING PULSES BASED ON LINEAR INTEGRATED AMPLIFIERS: Multivibrators based on integrated amplifiers. Analysis of behavior, transient phenomena and calculation procedure of multivibrators. Schmitt's circuit based on linear integrated amplifiers. Analysis of behavior and calculation procedure. Saw tooth voltage generator based on integrated amplifiers. Analysis of behavior and calculation procedure. 7. BLOCKING GENERATORS: Blocking generator. Blocking oscillator. Procedure of blocking generator calculation. 8. SIGNAL KONVERTORS: Analogue-to-digital convertors. Digital-to-analogue convertors. Pulse width modulator. U/f and f/U convertors. 9. CIRCUITS FOR DRIVING AND PROTECTION OF SEMICONDUCTOR COMPONENTS: Drivers. Behavior analysis of the circuits, transient phenomena and calculation procedure. Circuits for protection of semiconductor components. Behavior analysis of the circuits, transient phenomena and calculation procedure. 10. GALVANICAL ISOLATED TRANSFER OF PULSES: Pulse transformer. Optocuplers. Transfer of rectangular pulses and transient phenomena. Procedure of impulse transformer calculation.	
Literature		
Recommended	1. Notes and slides from lectures (See Faculty WEB Site) 2. Z. Pašić: „Impulsna elektronika", SP „Svjetlost", Zavod za udžbenike i nastavna sredstva, Sarajevo 1990. 3. M. Popović i D. Živković: 'Impulsna i digitalna elektronika', Akademska misao, Beograd, 2005.	
Additional	1. S. Tešići i D. Vasiljević: 'Osnovi elektronike', Građevinska knjiga, Beograd,	

	2009 2. B. Dokić: 'Energetska elektronika - pretvarači i regulatori', Akademska misao, Beograd, 2007	
Didactic methods		
	Lectures performed by the lecturer are illustrated with solving of problems of digital circuits and structures synthesis. Other examples and exam problems are considered and solved during tutorials. Homework which students receive is related to calculation of specified digital circuits and structures which students have to design individually in laboratory, and to test.	
Assesment		
	During the course student earn points according to the following system: - Attending classes and tutorials: 10 points. - Home assignments and laboratory exercise classes: maximum of 20 points, assuming solving 8 assignments evenly distributed throughout the semester, realized and tested in laboratory. - Partial exams: two written partial exams; each positively evaluated partial exam brings to 20 points. Final oral exam provides maximum of 30 points.	
Prerequisites		
	Electronic Elements and Circuits, Fundamentals of Electrical Engineering, Electrical Circuits 2	

Module title	Modeling and Simulation	
Module code	ETF AEO MS I-2460	
Programme	ETF-B ACE	
Module coordinator	Dr Bakir Lačević, Assistant Professor	
Teaching staff	Dr Bakir Lačević, Assistant Professor Alvin Abdagić, MoE, Teaching Assistant	
Year of study	2	
Semester	4	
Module type	Mandatory	
ECTS	5	
Lectures	39	
Laboratory exercises	21	
Tutorials	0	
Workload – Independent Study	65	
Module outcomes		
	• Acquired basic knowledge and skills about methods and techniques of dynamic systems modeling, • Capability to recognize and understand the analogies of dynamic models for systems of different types (mechanical, electrical, fluid, thermal, hybrid), • Ability to develop mathematical models for a variety of physical systems by means of systematic modeling methods, • Ability to transfer the developed models into a suitable simulation environment, so as capability ti analyze and interpret the simulation results, • Acquired knowledge from basic numerical methods necessary for the functioning of typical simulation environments.	

Module content		
	1. General aspects of modeling. Model generation. Physical systems modeling. Model types and limits of application. 2. Generalized variables and system elements. Notion of effort, flow, accumulated effort and flow. Energy, co-energy, Legendre transform. 3. Basic elements of mechanical, electrical, fluid and thermal systems. 4. Interconncection of system elemets. Principles of continuity of flow and compatibility of effort. 5. Systematic methods for modeling dynamic systems. Network (graph) – based methods. Variational mehods. Lagrange equations. Bond graphs. 6. Numerical methods for model simulation. Solvers for ordinary differential equations and differential algebraic equations.	
Literature		
Recommended	1. Peter E. Wellstead - Introduction to Physical System Modelling, 2005 electronic edition, 2. Adnan Salihbegović – Modeliranje Dinamičkih sistema, 1985, Svjetlost, 3. Brian C. Fabien - Analytical System Dynamics: Modeling and Simulation, 2009, Springer,	
Additional	1. Lennart Ljung and Torkel Glad - Modeling of Dynamic Systems, 1994, Prentice Hall , 2. Brian Roffel and Ben Betlem - Process Dynamics and Control: Modeling for Control and Prediction, 2006, Wiley & Sons, 3. B. Wayne Bequette– Process Dynamics: Modeling, Analysis, and Simulation, 1998, Prentice Hall	
Didactic methods		
	Lectures have a goal to provide a comprehensive overview of all the course modules. Lectures are performed in an aula in a manner which enables students to easily follow the course and immediately spot notions and methods that seem less clear to them. After completing each module of the course program, the lecturer demonstrates examples that enable students to master the terminology, instruments and methodology presented during lectures. Additional examples and problems are considered and solved during laboratory exercises (under the guidance of a tutor – teaching assistant). These activities are carried out in a way that enables continuous assessment of a student's interest and their active involvement in order to master the knowledge and techniques provided within the course.	
Assesment		
	During the semester, students collect points according to the following system (max **100** points): - Attendance: **10** points, - Partial exams: max 2 x 20 = **40** points, - Lab exercises reports and homework assignments: max **10** points, - Final, oral exam: max **40** points.	
Prerequisites		
	Mathematics for Engineers 1, Mathematics for Engineers 2, Physics for Engineers 2	

Module title	Linear Automatic Control Systems	
Module code	ETF AEO LS I-2460	
Programme	ETF-B ACE	
Module coordinator	Dr Mujo Hebibović, Full Professor	
Teaching staff	Dr Mujo Hebibović, Full Professor Almir Salihbegović, Teaching Assistant	

Year of study	2	
Semester	4	
Module type	Mandatory	
ECTS	5	
Lectures	36	
Laboratory exercises	8	
Tutorials	16	
Workload – Independent Study	65	
Module outcomes		
	Students should: Learn the basic elements and basic factual knowledge related to linear systems of automatic control; Students should obtain understanding and develop the ability to recognize elementary blocks and characteristic responses of the control systems; Students need to understand and master the mathematical description of the basic physical and technological principles, stability issues, quality behaviour in the new steady state, quality of transient performances, tracking of the reference signals.	
Module content		
	1. Introduction and basic concepts of control techniques; Task formulation – excitation signals to the dynamic system; Possible solution - control and regulation; Basic control specification; Stages of solving control tasks. 2. Describing the dynamic system with block structure: Introducing the block structure and its formation stages; Examples of control systems in the block structure; Basic blocks in the block structure; Linearization around the operating point; Decomposition of the block structure. 3. Control loop analysis: General block structure and equation of the control loop; Control characteristics in the open loop; Behavior of the control loop in the steady state; Definition of the system stability and basic algebraic stability criteria of the control system; Frequency characteristics and hodograph of the open loop; Nyquist stability criterion. 4. Synthesis (design) of the control loop: The performance specifications; Performing and obtaining the basic control structure; Problems in the implementation and different controller types, Rules for controller parameters tuning, Controller design for the interesting examples from the lecture. 5. The implementation of the controller: The transfer functions of the controllers and parameters that are used in practice to tune the controller. 6. Description of the dynamic system using state space representation; Transformation of the transfer function and linear differential equations to the state space representation and vice versa; Advantages of the state space representation. Transformation of the system state matrix. 7. Controllability and observability of the control system. State observer.	
Literature		
Recommended	1. Lecture notes (can be seen at the Faculty Web Page) 1. Mujo Hebibović, Linearni sistemi automatskog upravljanja, ETF u Sarajevu 2007.godine. 2. Adnan Tahirović, Mujo Hebibović, MATLAB u teoriji automatskog upravljanja – praktikum za laboratorijske vježbe, ETF u Sarajevu 2002. godine.	
Additional	1. Mujo Hebibović, Teorija automatskog upravljanja, ETF u Sarajevu 2003.godine. 2. Z. Vukić, Lj. Kuljača, Automatsko upravljanje – analiza linearnih sustava, Kigen, Zagreb 2004.godine.	

	3. Milić Stojić, Kontinualni sistemi automatskog upravljanja, Naučna knjiga Beograd. 4. Tugomir Šurina, Automatska regulacija, Školska knjiga Zagreb. 5. Thaler G. J., Automatic Control Systems, West publishing company, St. Paul, New York, Los Angeles, San Francisco,1989. godine.	
Didactic methods		
	The lectures will be conducted directly in the hall and accompanied by solving the problem examples which cover course material (36 hours), in a way that enables students to acquire knowledge and skills which need to be achieved within the framework of this course. **The laboratory exercises** (11 hours), led by tutors, are designed to help students to master the software tools that allow validation of the theoretical fundamentals that have been obtained at the lectures. With the help of tutors, students will be solving during **the tutorial** (13 hours) a number of examples that accompany the lectures, and samples of exam problems.	
Assesment		
	During the course students collect points according to the following system: - Attending classes, exercises and tutorials: 10 points; Student with more than three absences from lectures / exercises / tutorials cannot achieve these points. Students have to attend the classes of the laboratory exercises. - Continuous assesment in the form of four tests during the tutorial: each test with maximum of 2.5 points; - Partial exams: two partial exams, each partial exam with a maximum of 20 points; - Final oral exam that provides maximum 40 points.	
Prerequisites		
	Mathematics for Engineers 1, Mathematics for Engineers 2, Linear Algebra and Geometry	

Module title	Lab Work in Automatic Control and Informatics	
Module code	ETF AEI PAI I-2460	
Programme	ETF-B ACE, CI	
Module coordinator	Samim Konjicija, Assistant Professor	
Teaching staff	Dr Samim Konjicija, Assistant Professor Nedim Osmić, MSc, Senior Teaching Assistant Emir Sokić, MSc, Senior Teaching Assistant	
Year of study	2	
Semester	4	
Module type	Elective	
ECTS	5	
Lectures	11	
Laboratory exercises	39	
Tutorials	10	
Workload – Independent Study	65	
Module outcomes		
	Course goal is to consolidate theoretical knowledge of students acquired through various courses, by solving problems in laboratory and to develop	

	engineering skills and teamwork skills. After successful completion of the course, the students will be able to: • understand practical problem and identify a proper approach for solving it, • analyze and decompose a practical problem into subproblems, which can be solved using available knowledge, • conduct experimental tests, in order to acquire required data, • conduct data acquisition and analalyze the data acquired from experiment, • apply adequate methods to solve the subproblems and the problem as a whole, • document the procedures and results.	
Module content		
	1. Matlab/Simulink: basics, expressions, graphic representation of data, development of graphic user interface 2. LabVIEW: basics, realization and use of virtual instruments 3. Data acquisition: typical modules for data acquisition, wiring the modules and measurement of electrical values: analog input/output, digital input/output, module configuration: configuration of inputs/outputs, configuring sampling rate, triggers, use of module and data acquisition 4. Measurement of non-electrical values: measurement of temperature (NTC, PTC); measurement of distance (ultrasonic sensor of distance, infrared sensor of distance); measurement of level; measurement of flow; sensor characteristics; recording sensor characteristics, sensor linearization 5. Use of programmable logic controller (PLC) for control: bang-bang control: analysis, modeling, simulation and realization of bang-bang controller for control of temperature, level, pressure; logic control: realization of logic functions on PLC; finite state machines on PLC. 6. PID controller: identification and modeling of linear systems, simulation of control sistems with PID controller, realization of PID controller. 7. Realization of project: project which covers topics of the course.	
Literature		
Recommended	1. Notes and slides from lectures (See Faculty WEB Site) 2. Samim Konjicija: Praktikum automatike i informatike, skripta, ETF Sarajevo, 2007.	
Additional	1. Matlab Documentation: http://www.mathworks.com/access/helpdesk/help/techdoc/matlab.shtml 2. LabVIEW Documentation: http://www.ni.com/labview/	
Didactic methods		
	The course is performed in form of laboratory exercises, which are held each week. Students work on assignments in teams consisting of a few students, insisting on formalization of the procedure of team work. Each laboratory exercise lasts several lab sessions, and the students do proper preparation prior to access to the equipment. After successfully conducted exercise, the students hand over the written reports and present them. Lectures are held prior to each of the laboratory assignment (at least one week ahead) and they are intended for presenting the problem which will be covered by the laboratory exercise. The problem in focus of the laboratory exercise is presented, and the students are advised on how to approach to the realization of the assignment. Based on the information given during lectures, the students analyze the laboratory assignment, agree on decomposition and split the assignments among team members, and study literature adequate for successful completion of the assignment. Project assignment is realized in the second half of the semester and it represents a more complex problem. During realization of the project assignment, students are obliged to formally approach to solving the problem	

	through identification of elements and objects, modeling, simulation and implementation of the solution. Each step during the realization ought to be adequately documented, following the recommendations and requirements explained on lectures.	
Assessment		
	Assessment is as follows: • Attendance on lectures and exercises (max. 10 points). Student with more than three absences from lectures and/or laboratory exercises doesn't get these points. • Preparation for laboratory exercises and presentation of results of exercises and project (max. 40 points). • Homeworks (max. 10 points) • Integral exam (max. 20 points) • Final exam (max. 20 points) In order to begin work in laboratory, the students should to demonstrate adequate preparation for laboratory exercise, and after successful completion of work in laboratory, they produce a report on realization of the laboratory exercise or project, where they explain theoretical analysis of the problem, describe problem decomposition, approach to collecting and analysis of the data, explain models, simulation results and results acquired from implemented solution. The report for a laboratory exercise/project is presented and defended according to the agreed schedule In the end of the semester, the students have an integral written exam, which covers the topics of the course (laboratory exercises and homeworks). Students who collect less than 10 points on the integral exam ought to take a remedial exam. Students who collect min. 40 points from all the mentioned activities take a final exam. On final exam, the students orally answer the questions about the topics covered on laboratory exercises and demonstrate solving simpler versions of similar problems. In order to successfully pass the exam, the student should collect at least 55 points, including attendance, homeworks, individual preparations and presentations of laboratory exercises and roject, integral and final exam.	
Prerequisites		
	Fundamentals of Electrical Engineering, Fundamentals of Computing	

Module title	Lab Work in Electrical Engineering and Electronics	
Module code	ETF AEI PEE I-2460	
Programme	ETF-B ACE	
Module coordinator	Dr Abdulah Akšamović, Associate Professor	
Teaching staff	Dr Abdulah Akšamović, Associate Professor Alvin Abdagić, MoE, Teaching Assistant	
Year of study	2	
Semester	4	
Module type	Elective	
ECTS	5	
Lectures	11	
Laboratory exercises	39	
Tutorials	10	
Workload –	65	

Independent Study		
Module outcomes		
	Upon successful completion of this course, students should be able to independently perform experiments in the area of basic electrical engineering and electronics and skillfully use electrical measurement devices. They should be acquainted with techniques of electronic circuits design with discrete components and LSI components using CAD tools. Students should comprehend the principles of operation of discrete electronic components and circuits. Through work on the project, they learn how to work in a team and independently solve somewhat complex problems.	
Module content		
	1. Electrical instrumentation: oscilloscope, signal generator, laboratory voltage sources, multi-meters. 2. Measurement of transfer functions of electronic components: diodes, transistors, thermistors. 3. Design of electronic circuits. CAD tools. Electronic schematics. Symbols. Standards. Design and manufacturing of PCBs. Soldering. Testing. 4. Measurement of frequency and phase response of electronic components and circuits: amplifiers and RC filters. 5. Realization of DC voltage source. Linear voltage regulators with transistors. Integrated circuit voltage regulators. 6. Realization of sine wave signal voltage source. Oscillators. Positive feedback. 7. Realization of square wave signal voltage source. Multivibrators with discrete components. Universal timer NE555. 8. Realization of circuits with operational amplifiers: amplifier, summing amplifier, differentiator, integrator, comparator. Ideal diode circuit. Wien bridge oscillator. Instrumentation amplifier. 9. Electronic realization of analogue controllers. P, PI, bang-bang (on-off) controllers, feedback. 10. Project assignment in teams.	
Literature		
Recommended	1. A. Akšamović, M.Hebibović, *Elektronika s aspektom primjene u regulaciji*, Sarajevo, 2010.	
Additional	1. Thomas L. Floyd, *Electronics Devices*, Prentice Hall, 2012. 2. Stephen E. Derenzo, Practical Interfacing in the Laboratory, Berkeley, California, Cambridge University Press, 2003. 3. Sergio Franco, 'Design with operational amplifiers and analog integrated circuits', Mc Graw Hill, 2002.	
Didactic methods		
	This course is thought through introductory lectures in aula, organized for all students in the duration of one class for each topic (in total of 11 classes). These lectures allow students to prepare for labs. As part of the preparation for labs, students make the necessary calculations as well as simulations using a software suite for circuit simulation. Split in groups, they attend the labs in an electronics laboratory for the total duration of 33 classes. All the work in labs is performed individually when adequate equipment is available. The obtained results, along with work done as the prepartion for the labs is submitted as a report which is then evaluated. In the second half of the semester, students work on a project assigment in groups of up to four in duration of 6 classes under mentorship and additional 20 classes of independant work.	
Assessment		
	Through the duration of the course, points are accumulated as follows: • attendance to all classes: up to 10 points;	

	• preparation for the labs, work and reports: up to 10 points; • partial exam: up to 40 points; • project assigment: up to 40 points.	
Prerequisites		
	Electronic Elements and Circuits, Analogue Electronics, Electrical Measurements	

Module title	Electrical Machines	
Module code	ETF EEI EM I-3570	
Programme	ETF-B PE, ACE	
Module coordinator	Dr Šemsudin Mašić, Full Professor	
Teaching staff	Dr Šemsudin Mašić, Full Professor Dr Senad Smaka, Assistant Professor	
Year of study	3	
Semester	5	
Module type	Elective	
ECTS	5	
Lectures	39	
Laboratory exercises	16	
Tutorials	15	
Workload – Independent Study	80	
Module outcomes		
	At the end of the module, students should be able to: • apply the principles of electromechanical energy conversion for the analysis of elementary electric machines with linear and rotary motion; • describe and present the structure and characteristics of basic types of electric machines that are used in practice; • apply their knowledge to solve problems of medium complexity in the area of electrical machines; • independently conduct basic testing of electrical machines in laboratory conditions, presents the test results, implement the analysis and interpretation of the results; • continue to monitor classes in other modules whose content is related to electrical machines and their application.	
Module content		
	1. Introduction to electrical machines: Electromechanical energy conversion principles. Elementary electrical machines. Generated voltage and developed electromagnetic torque. Stator and rotor excitations and magnetic circuits of electrical machines. Magnetic fields in rotating machines: DC, single-phase and polyphase. 2. Transformers: Construction of transformers. The ideal and real single-phase transformers. Transformer equivalent circuits. Phasor diagrams. No load and short circuit tests. Efficiency. Three-phase transformers. Three-phase transformers connection. Parallel operation. Autotransformers. 3. Induction machines: Construction principles: wound and cage rotors. Principles of operation: motor, generator, and braking regions. Equivalent circuit. Losses and efficiency. Electromagnetic torque and torque-speed characteristic. No load and blocked rotor tests. Induction	

	motor starting. Induction motor speed control basics. Induction generator. Single-phase induction motors. Special induction machines. 4. Synchronous machines: Basic structures. Excitation systems. Principles of operation: motor and generator. Synchronization of a generator. Synchronous motor starting. Round rotor synchronous machines: equivalent circuit, voltage equations, phasor diagrams, synchronous machine on an infinite bus, generator stand-alone operation, losses and efficiency, torque-load angle characteristic. Salient poles synchronous machines: equivalent circuit, phasor diagrams, power and load angle. 5. DC machines: Construction of DC machines. Principles of operation: motor and generator. Principle of commutation. Armature reaction. Generated voltage. Developed torque. Methods of main field excitation. Losses and efficiency. DC motors characteristics. DC generator characteristics.	
Literature		
Recommended	1. Š. Mašić - Električni strojevi, Univerzitet u Sarajevu, Elektrotehnički fakultet u Sarajevu, 2005.	
Additional	2. R. Wolf - Osnove električnih strojeva, Školska knjiga Zagreb, 1995. 3. A. E. Fitzgerald, C. Kinsley, S. D. Umans - Electric machinery, McGraw - Hill, 1990.	
Didactic methods		
	Teaching techniques for the modules are direct lectures, tutorials and laboratory exercises. • The lectures are performing by the module coordinator, supported by prepared presentations. The lectures are used to introduce students to the theoretical aspects and basic concepts concerning the content of the module. • Solving and analyzing cases and open problems during tutorials shall deepen the students' knowledge. Tutorials are an opportunity to the students to practically implement theoretical knowledge acquired during the lectures and to discuss with tutor on questions relevant to the content of the module. • During laboratory exercises, students in small groups, with the guidance of tutor, become more familiar with the laboratory work, construction of electrical machines, instrumentation and measurement procedures. The students independently perform various tests on electrical machines in order to determine their characteristics.	
Assessment		
	The contributions of all students' activities during module run are rated according to the following scale: • Attending lecture classes, tutorials and laboratory exercises: 10 points. Maximum of three unexcused absences during the semester are allowed for all teaching activities. • Performing laboratory exercises, and preparation of reports: a maximum of 10 points can be awarded for written reports from the laboratory exercises performed during the semester. A student who unjustifiably fails to attend laboratory exercise cannot submit a written report. Also, late submissions of the reports will not be accepted. • Midterm exams: two midterm exams, each of them can bring a maximum of 20 points. Each student prepares and submits a written report from the lab. The report contains tables with the results of measurements and calculations, diagrams for the graphical presentation of the test results and corresponding conclusions. The first midterm exam is organized in the eighth week of the semester, and the second midterm exam in the sixteenth week. There are two terms for	

	the makeup exam. The first makeup exam is organized two weeks after the second midterm exam. The second makeup exam is organized after the summer break, at the end of the current school year, usually in late August or early September. The midterm and makeup exams in this module are a standard closed-book written examination, lasts 100 to 120 minutes. The exams are usually consists of: • Questions without offered answers aimed to check whether the student has a basic theoretical knowledge related to the module content. The correct answers to these questions can bring a maximum of 5 points. • Two problems with open answers that can bring a maximum of 10 points. • Theoretical questions or simple problems with offered possible answers (multiple choice form of assessment), which could bring a maximum of 5 points. It is necessary that the student achieve a minimum of 50% points on each of the two midterm exams in order to receive a passing grade in this module, regardless of the number of points that are earned for the attending classes and for the laboratory reports. A student who has collected 20 points or less for class attendance, reports from laboratory exercises, midterm exams and first makeup exam can access second makeup exam without any restrictions. If the student has passed the midterm exam, and wants to try to improve the result during makeup exams, she (he) must notify the members of the teaching staff. The result achieved on midterm exam will be deleted. A student who at the end of the current school year is not achieved at least 50% points on one or both midterm exams is required to re-attend this module next year. The results that have been achieved in the current school year will be deleted. The final oral exam is optional and applies only to students who are not satisfied with the proposed final grade. The proposal of the final grade is formed on the basis of the results achieved in written midterm and/or makeup exams, evaluation of activities and reports from labs and student attendance record. The final oral exam consists of questions related to the topic theoretical content of the module.	
Prerequisites		
	Fundamentals of Electrical Engineering, Electrical circuits 1, Electrical circuits 2	

Module title	Actuators	
Module code	ETF AEI AK I-2460	
Programme	ETF-B ACE	
Module coordinator	Dr Jasmin Velagić, Full Professor	
Teaching staff	Dr Jasmin Velagić, Full Professor Mr Nedim Osmić, Senior Teaching Assistant	
Year of study	2	
Semester	4	
Module type	Elective	
ECTS	5	
Lectures	39	
Laboratory exercises	16	
Tutorials	5	

Workload – Independent Study	65	
Module outcomes		
	After finishing the module, the student will gain the basic knowledge about actuators, their properties and characteristics relevant to their applications. The presented contents will also provide student to adopt and understand underlying concepts of modeling, simulation and control of various actuator types as well as analyzing their static and dynamic behaviors.	
Module content		
	1. The basic fundamentals, classifications and applications of actuators. Constructions, work principles and types of DC motors. Mechanical and electromechanical characteristics of DC motor. DC motors with independent excitation and permanent magnets. Static and dynamic behaviors of DC motor. Modeling and simulation. Transistor amplifiers and thyristor converters. Controlled thyristor power drive. Transistor converter (chopper). Pulse-Width-Modulation. 2. Introduction to stepper motors. Basic properties and parameters. Elements of stepper motor control system: power amplifier, controller of the phase state and regulator. Permanent magnet, variable-reluctance and hybrid stepper motors. Unipolar and bipolar power drives for stepper motors. Modeling of the stepper motor. 3. Asynchronous (induction) motor. Construction, working principles and classification of asynchronous motors. Modeling of asynchronous motor, the example of three phase symmetric asynchronous motor. Control of asynchronous motor. Frequency converter. 4. Fundamentals of pneumatic and hydraulic actuators. Static and dynamic characteristics. Types of pneumatic motors. Regulation valves and their characteristics. Types of hydraulic actuators: hydraulic pump, valve and motor. Static characteristics of pump. Hydraulic control systems. Applications of pneumatic and hydraulic actuators. 5. MEMS actuators and technologies. Piezoelectric actuators and materials. Types of piezoelectric actuators. Static and dynamic behaviors of piezo actuators. Applications of piezo actuators. Electrostatic and electromagnetic micro actuators. Comb drive, rotation motor and microswitch. Constructions of electromagnetic actuators and winding. Example of realization of electromagnetic actuators. Thermal actuation. Thermoelastic, thermal bimorph and electrothermal bimorph actuators. Applications of MEMS actuators.	
Literature		
Recommended	1. Notes and slides from lectures (See Faculty WEB site). 2. H. Funacubo, *Actuators for Control (Precision Machinery and Robotics)*, CRC Press, New York, 1991. 3. H. Janocha, *Actuators: Basics and Applications*, Springer Verlag, Berlin, 2004. 4. C. Da Silva, *Sensors and Actuators*, CRC Press, New York, 2007.	
Additional	1. N. Manring, *Hydraulic Control Systems*, John Willey and Sons, New York, 2005. 2. I.L. Krivts & G.V. Krejnin, *Pneumatic Actuating Systems for Automatic Equipment*, CRC Press, New York, 2006.	
Didactic methods		
	Direct lectures are performed in an aula and they are supported by stating and solving of problems done by the lecturer with aim to enable students to adopt methods introduced during lectures. The homeworks with assigned problems independently solved by students.	

	Laboratory exercises. Students are introduced to software and hardware environment in laboratory and with tutor help work on previously presented material and assigned problems.	
Assessment		
	The grading of the course is as follows: - Attending classes and tutorials: 10 points, - Home assignments: max. 10 points, - Laboratory exercises: max. 10 points, - Partial exams at mid and end of semester: max. 40 points, - Final exam: max. 30 points.	
Prerequisites		
	Physics for Engineers 2, Fundamentals of Electrical Engineering, Electronic Elements and Circuits	

Module title	Fundamentals of Database Systems	
Module code	ETF RIO OBP I-2460	
Programme	ETF-B, ACE, CI	
Module coordinator	Dr Almir Karabegović, Assistant Professor	
Teaching staff	Dr Almir Karabegović, Assistant Professor Emir Buza, MSc, Senior Assistant	
Year of study	2	
Semester	4	
Module type	Elective	
ECTS	5	
Lectures	40	
Laboratory exercises	20	
Tutorials	0	
Workload – Independent Study	65	
Module outcomes		
	The goal of this module is to provide fundamental knowledge of database management systems. After successful completion of the course, student will be able to: - Define and identify the basic elements of database management systems - Analyze and apply the basic principles of database management systems - Develop the ability for self-learning and applying the acquired knowledge on real-world example	
Module content		
	1. Introduction to databases: Historical overview of database management systems (DBMS). Types of database management systems. Architecture of database management systems. Basic elements of database management systems. 2. Relation data model: Elements of relation data model. Types of relation among tables. Entity relationship diagram. 3. Relational query language: Standards of the relational query language. Structured Query Language - SQL. SQL commands for creation objects in the database. SQL commands for: query, insert and delete data in the database. 4. Advanced data search: General principles of joining tables. Cartesian	

	product. Inner join versus outer join. Joining two or more tables under equality condition. Joining two or more tables on any condition except under equality condition. 5. Data integrity: definition of data integrity. Basic ways of defining of integrity conditions. Domain attributes and its implementation through data integrity. 6. Stored procedures, functions and packages into the database. The general difference among stored objects. Scalar functions. Group functions. User defined stored functions and procedures. 7. Data dependence: Functional dependence. Multiple dependences. 8. Normalization: anomalies of insertion, modifications and deletion. Normal forms, normalization procedures.	
Literature		
Recommended	1. Ramez Elmasri, Shamkant B. Navathe [2000], Fundamentals of Database Systems, Addison-Wesley, 2000. 2. C.J. Date, Database in Depth: The Relational Model for Practitioners, O'Reilly, 2005. 3. ANSI/ISO/IEC International Standard (IS), Database Language SQL, 1999.	
Additional	1. H. Garcia-Molina, J. D. Ullman, J. D. Widom: Database Systems: The Complete Book, Prentice-Hall, 2001. 2. Silberschatz, H. F. Korth, S. Sundarshan: Database System Concepts, McGraw Hill, 2001.	
Didactic methods		
	The course is conducted through theoretical lectures in which concepts of database management systems are presented. These lectures are supported by creating tasks and presenting many examples in order for student to better acquire knowledge from this course. On laboratory exercises students solve practical assignments where it is required from them to analyze the problem and compare it with theoretical and practical examples from lectures. These activities are organized to enable continuous assessment through term paper and practical exercise of level of preparedness of students required to comprehend knowledge and skills required from them to reach in this course.	
Assesment		
	During the course students earn points according to the following system: - Attending classes and tutorials: 10 points, student with more than three absences from laboratory exercises cannot get these points. - Term paper: maximum of 10 points. Student is required to prepare one term paper uniformly distributed throughout the semester. - Partial exams: two partial exams; each positively evaluated partial exam with 20 points. - Students who gained less than 20 points during the semester must repeat the course. Students who earned 40 or more points during the semester will take a final exam; the exam consists of discussion of problems from partial exams, home assignments and answers to simple questions related to course topics. Final oral exam provides maximum of 40 points. In order to get positive final grade, students must earn minimum of 20 points in this exam. Student failing to earn the minimum must take the repeat oral exam. Student, who earned 20 or more, and less than 40 points during the semester, will have to take the repeat exam. The repeat exam is organized in the following manner: - Written part is structured similarly to partial written exam, during which students solve problems in topics they failed on partial exams (less than 10 points);	

	- Oral part is structured the same as the oral part of the final exam. Only students who managed to earn total score of 40 or more points in written part of the repeat exam will be allowed to take the oral part of the repeat exam, where the mentioned score consists of points earned through attending lectures, solving home assignments, passing partial exams and passing the written part of repeat exam. Oral repeat exam provides maximum of 40 points. In order to achieve positive final grade students must earn minimum of 20 points in this exam. Student failing to earn the minimum will have to retake the module.	
Prerequisites		
	Algorithms and Data Structures	

Module title	Fundamentals of Optoelectronics	
Module code	ETF AEI OO I-2450	
Programme	ETF-B ACE, TC	
Module coordinator	Dr Melita Ahić-Đokić, Full Professor	
Teaching staff	Dr Nasuf Hadžiahmetović, Assistant Professor Mirza Milišić, MSc, Senior Teaching Assistant	
Year of study	2	
Semester	4	
Module type	Elective	
ECTS	5	
Lectures	36	
Laboratory exercises	7	
Tutorials	7	
Workload – Independent Study	75	
Module outcomes		
	Course has a goal to present basic concepts from optoelectronics necessary for the understanding of creation, transmission, reception and processing of optic signals. Besides, students need to acquire essential knowledge from optic communications necessary for design, realization and maintenance of optic communications systems.	
Module content		
	1. Light emission and absorption: types of electron emission (thermionic, auto-electronic, secondary, photo-electronic, exoelectron emission); Schrödinger equation. 2. External and internal photo-effect: mechanism of this phenomenon, photo-conductivity, photo-EMF, types of absorption in semiconductors (fundamental absorption, dopant absorption, acceptor-donor absorption, absorption of free charge carriers, crystal lattice absorption, exciton absorption, plasmonic absorption), photo-elements, photo-resistors, noise types in photo-resistors. 3. Liquid crystals: mesomorphic state, types of liquid crystals, electric properties of liquid crystals, applications of liquid crystals, liquid crystal based indicators, liquid crystals as indicators of temperature. 4. Optical waveguides: concept, types, propagation in waveguides, dispersion systems, waveguides with circular cross-section. 5. Optical fibers: concept and types, step-index fiber, graded-index fiber, basic characteristic of modes in optical fibers, fiber optic manufacturing technology. 6. Fiber optic cables: cable types, production of fiber optic cables, constructions and appearances curvature by the cabling of optic	

<table>
<tr><td></td><td>fibers.
7. Signal attenuation in optical fiber: concept, causes of attenuation, attenuation curve, absorption in material, material dispersion, scattering in material, waveguide dispersion, radiation due to fiber bending, effects dependent on fiber coating.
8. Group delay and dispersion in step-index optical fibers: concept, dispersion coefficient, intermode dispersion, material dispersion and waveguide dispersion.
9. Spectral line width and open resonators: Lorentz curve, open resonators, calculation of open resonator, purpose and quality of open resonator.
10. Optical transmitters: lasers and LEDs as optical transmitters.
11. Optical receivers: PIN photodiodes, APD photodiodes, receiver sensitivity.
12. Fiber optic transmission systems: digital lightwave system structure, point-to-point transmission systems, link budget of the point-to-point transmission system and dependence of link length on transmission rate.</td><td></td></tr>
<tr><td colspan="3">Literature</td></tr>
<tr><td>Recommended</td><td>1. M.Cvijetić, „Digitalne svjetlovodne telekomunikacije“, Beograd 1988.
2. Bilješke i slajdovi s predavanja (WEB strana Fakulteta).
3. D.Milatović, „Optoelektronika“, Sarajevo 1987.</td><td></td></tr>
<tr><td>Additional</td><td>1. J.A.Buck: Fundamentals of Optical Fibers, USA 1995.
2. J.C.Palais: Fiber Optic Communications, New Jersy 1998.
3. S.O.Kasap: Optoelectronics and Photonics, New Jersy 2001.
4. O.Wada: Optoelectronic Integration, Kluwer Academic Publishers 1994.</td><td></td></tr>
<tr><td colspan="3">Didactic methods</td></tr>
<tr><td></td><td>Lectures are presented directly in lecture-hall. Throughout tutorial, under guidance of tutor, typical problems are solved, including problems from previous exams. Throughout laboratory exercises, under guidance of tutor, experiments are carried out in laboratory. Lectures, slides, tutorials, preparations for lab exercises, and additional information are available at Faculty Courseware: http://c2.etf.unsa.ba.</td><td></td></tr>
<tr><td colspan="3">Assesment</td></tr>
<tr><td></td><td>The contribution of all activities are rated according to the following scale:
<table>
<tr><td>Activity</td><td>Max. points to be awarded</td></tr>
<tr><td>Regular attendance
HW / LE
1st midterm exam
2nd midterm exam
Final exam</td><td>10
10
20
20
40</td></tr>
</table>
Regular attendance means that student must be present on all forms of the module’s delivery. Students with a maximum of three unexcused absences during the semester earn 10 points.
By solving of homework(s) and/or laboratory exercises (HW/LE), student can earn up to 10 points.
Midterm exam is considered to be passed by a student if he earned at least 10 points (out of 20). First midterm exams are in the 8th week, and second midterm exams are in the 16th week of the semester. Students who failed first and/or second midterm exam are allowed to go through the makeup exam at the end of the semester. Second makeup exam (extended makeup exam) takes place in September prior to the beginning of new academic year.
The final exam takes place in the first week after second midterm exams.</td><td></td></tr>
</table>

	Makeup final exam takes place in the first week after makeup exams. Second final exam takes place in the first week after second makeup exam. The midterm and makeup exams are written. Duration of midterm and makeup exams is from 90 to 120 minutes. During midterm and makeup exams students solves the problems that are of the same and/or similar type as those solved during the lectures and tutorials. Final exam can be written or oral and most frequently is in written form.	
Prerequisites		
	Physics for Engineers 2, Electronic Elements and Circuits, Electrical Circuits 2	

Module title	Telecommunication Basics	
Module code	ETF AEI OTK I-2460	
Study	ETF-B ACE	
Module coordinator	Dr Mesud Hadžialić, Associate Professor	
Teaching staff	Dr Mesud Hadžialić, Associate Professor Kenan Turbić, MoE, Teaching Assistant	
Year of study	2	
Semester	4	
Module type	Elective	
ECTS	5	
Lectures	42	
Laboratory exercises	0	
Tutorials	14	
Workload – Independent Study	70	
Module outcomes		
	Students acquire basic knowledge about modern telecommunication networks: telecommunication models, topologies, architecture, infrastructure, communication protocols and IP network models. **Upon successful completion of the course, students should be able to:** - understand and use telecommunication networks and technologies for support in solving specific problems in the area of electric power engineering - estimate basic bounds for system parameters and quality parameters in telecommunication networks supporting services in the area of electric power engineering	
Module content		
	1. **Information and telecommunication networks:** Information characteristics. Information networks. Telecommunication network. Discrete and continuous-time systems. Information and information content. Entropy. Information sources and signals. 2. **Telecommunication channels**: Discrete channel. Signals: signal presentation, deterministic and random signals. Continuous-time channel. Characteristics of communication in noisy continuous-time channels. Capacity of band-limited channels. Channel and signal encoders. Line coding. Digital modulation. Channel information volume. 3. **Multi-user communication:** Multiple access techniques and resource sharing: TDMA, FDMA, CDMA and CSMA. 4. **Transmission medium**: Copper: telephone twisted pair, coax cable	

	and power lines. Optical fiber. Radio channel. 5. **Analog-digital conversion:** Discrete representation of continuous-time signals. Sampling. Quantization. Analog-digital conversion procedure. 6. **Multiplexing:** Multiplexing techniques. Deterministic and random multiplex. Digital hierarchy. 7. **Telecommunication networks:** ISO model as a reference. TCP/IP model. Layers, interfaces and services. Network and terminal equipment. 8. **Communication protocols:** ARQ and HDLC protocols. 9. **Local computer networks:** Topology choice. Protocols. Interconnections in LAN: hub, repeater, bridge, router. IEEE 802.x Ethernet standards family. FDDI. FDDI-II. Local wireless networks: IEEE 802.11 (WLAN), IEEE 802.15 (WPAN) and IEEE 802.16 (WiMAX). 10. **Telecommunication network infrastructure:** Technology for voice, data and video transmission. Existing and future service demands. 11. **Internet:** Inter-networking, TCP/IP protocol set. IP protocol, functionalities and packet structure. IP addressing, subnetting and supernetting. ARP protocol. Internet routing. Interior gateway protocols: RIP, OSPF. Exterior gateway protocols: BGP.	
Literature		
Recommended	1. Slides and lecture notes (available at faculty website); 2. K. Suruliz i M. Hadžialić, *Statistička teorija telekomunikacija*, Elektrotehnički fakultet u Sarajevu, 2009, ISBN 978-9958-629-27-3; 3. L. Goleniewski, *Telecommunications Essentials*, Addison-Wesley, 2001.	
Additional	1. Bažant i dr, *Osnovne arhitekture mreža*, Element, 2004. 2. R. Horak, H. Newton, A.A. Miller, *Comunications System and Networks,* Y. Wiley, 2002. 3. J. F. Kurose, K.W. Ross, *Internet and Communication Networks*, Mc Graw-Hill, 2003.	
Didactic methods		
	Lectures are performed in a lecture hall. Each lecture is followed by examples of specific problems in the area of the topic, so students would master the required knowledge and skills. Through tutorials, led by teaching assistant, additional problems are being solved in order to obtain skills and methodology of problem solving, which afterwards has for a goal gaining the ability of solving practical problems and dealing with specific situations. Particularly, focus in maintained at solving problems in the area of IP networks: IP addressing, subnetting and supernetting.	
Assessment		
	During the course students acquire points according to the following system: **Attending classes and tutorials:** 10 points, student with more then three absences from lectures and/or tutorials and/or laboratory exercises can not get these points. **Home assignments:** maximum of 10 points, assuming solving 5 to 10 assignments equally distributed throughout the semester, with the maximum of 5 points per assignment; Short quizzes can be used to assess the work on assignments. Knowledge obtained through laboratory exercises is assessed by teaching assistant. **Midterm exams:** two midterm exams; each positively evaluated midterm exam giving 20 points. Students are given 90-120 minutes to take the midterm exam which is constructed from the following:	

	-short questions -questions with multiple answers -problem sets Minimum of 10 points is required for students to take the final exam. Students who gained less then 20 points during the semester must repeat the course (re-enroll). **Students who gained 40 or more points during the semester can take the final exam**, consisted of simple problem sets and short questions related to the course topics. Final oral exam gives maximum of 40 points. In order to complete the course, students must gain a minimum of 15 points at this exam. Student failing to do so, must take the oral makeup exam. **Students who gained 20 or more, and less than 40 points during the semester,** have to pass the makeup exam. The makeup exam is organized in the following manner: -written part structured same as midterm exam, during which students solve problems related to topics in which they did not achieve required grade (10 or more points) taking the midterm; -oral part structured the same as the oral part of the final exam. **Only students who managed to achieve total score of 40 or more points in written part of the makeup exam are allowed to approach oral part of the makeup exam**, where the mentioned score is consisted of points gained through attending lectures, solving home assignments, midterm exams and the written part of makeup exam. Oral makeup exam gives the maximum of 40 points. In order to pass the course, students must achieve minimum of 20 points at this exam. Students failing to achieve the minimum have to re-enroll for this course.	
Prerequisites		
	Linear Algebra and Geometry, Mathematics for Engineers 1	

Module title	Digital Integrated Circuits	
Module code	ETF AEO DIK I-3560	
Programme	ETF-B ACE	
Module coordinator	Dr Mustafa Musić, Associate Professor	
Teaching staff	Dr Mustafa Musić, Associate Professor. Senad Huseinbegović, MSc, Senior Teaching Assistant	
Year of study	3	
Semester	5	
Module type	Mandatory	
ECTS	5	
Lectures	36	
Laboratory exercises	24	
Tutorials	0	
Workload – Independent Study	65	
Module outcomes		
	The student should be able to: • To understand the fundamentals of manufacturing process of integrated circuits using planar process, and the construction techniques of hybrid integrated circuits. • To understand the topology of fundamental logic gates in TTL, ECL, I2L and CMOS technology. • To execute the analysis and synthesis of different form signals based on the basic TTL and CMOS circuits.	

	• To know the topologies and principles of the fundamental blocks of digital systems: flip-flops, registers, semiconductor and memory.	
Module content		
	1. Overview of integrated circuits. Classification of integrated circuits. Monolithic integrated circuits. Planar silicon processes: epitaxial growth, oxidation, diffusion, photolithography, metallization. Realization components of monolithic integrated circuits (pn transition, npn and pnp transistors, Schottky transistors, MOSFET, CMOS, resistance, capacity). Types and features of MOS structures. Complex structures. Development tendency. 2. Hybrid integrated circuits. Hybrid thin film integrated circuits. Hybrid thick film integrated circuits. Comparison of monolithic and hybrid integrated circuits. Selection factors for integrated circuits technology: features, price, volume and weight, packaging, reliability. 3. Genesis of integrated circuits: DCTL, RTL, DTL, HLL, HTL. Transfer characteristic. Threshold voltage. Logic signal levels. Noise margin. Time delay integrated circuits. Transistor-transistor logic. Emitter coupled logic. Three state logic. Integrated injection logic. MOC and CMOS logic circuits. Logic circuits selection. Load integrated circuits. 4. Flip-flops. RS flip-flop. T flip-flop. RST flip-flop. D flip-flop. JK flip-flop. MS flip-flop. 5. Pulse generating circuits (bipolar, MOS i CMOS): time-delay cirucits, monostable multivibrators, astable multivibrators. 6. Registers. Stationary registers. Shift registers. Static and dynamic logics. Dynamic two-phase shift register. Relation and non-relation register cells. 7. Read only memory (ROM). MOS read only memory. ROM programming. ROM applications. Programmable memories. Erasable programmable memories. Electrically erasable programmable memories. Random access memories (RAM). RAM structure. RAM elements: Basic cells of bipolar RAM. Basic cells of static MOS RAM. Dynamic random access memories (DRAM). Basic cells of dynamic RAM. 1T DRAM cell. 3T DRAM cell.	
Literature		
Recommended	1. Notes and slides from lectures (See Faculty WEB Site) 2. Uroš Peruško, 'Digitalna elektronika'. Školska knjiga Zagreb, 1993.	
Additional	1. Wallter A. Triebel, 'Integrated Digital Electronics', Prentice Hall 1985. 2. Anil K. Maini, 'Digital Electronics - Principles, Devices and Applications', John Wiley & Sons Ltd, 2007. London.	
Didactic methods		
	Lectures performed by the lecturer are illustrated with solving of problems from synthesis of digital integrated circuits and structures. Homework which students receive is related to analisys and syntesis of concrete digital integrated circuits and structures which are individually implemented and tested in laboratory.	
Assessment		
	During the course students earn points according to the following system: - Attending lectures and laboratory exercises: 10 points, student with more than three absences from lectures and/or laboratory exercises cannot get these points. All laboratory exercises, students are required to attend. - Home works and laboratory exercises: maximum of 10 points; prescribing 12 home works equally distributed throughout the term which are tested by laboratory exercises. - Partial exams: two partial written exams; each partial exam by maximum 20 points. - Final oral exam provides maximum of 40 points.	

Prerequisites		
	Electrical Circuits 2, Digital Electronics	

Module title	Digital Control Systems	
Module code	ETF AEO DSU I-3560	
Programme	ETF-B ACE	
Module coordinator	Dr Mujo Hebibović, Full Professor	
Teaching staff	Dr Mujo Hebibović, Full Professor Emir Sokić, MSc, Senior Teaching Assistant	
Year of study	3	
Semester	5	
Module type	Mandatory	
ECTS	5	
Lectures	36	
Laboratory exercises	8	
Tutorials	16	
Workload – Independent Study	65	
Module outcomes		
	Students should: Learn the basic elements and basic factual knowledge related to digital automatic control systems; Understand discrete transfer functions and state space representations; Understand and develop the ability to choose an adequate sampling period; Establish correlation between analog and discrete signals and systems; Understand and master the mathematical methods of discretization, stability issues and quality assessment of digital control system; Master the knowledge and skills needed for implementation of a digital controller on a digital computer.	
Module content		
	1. The structure of the digital control system. 2. Quasi-continuous control: Approximation of continuous time controller with a discrete time controller algorithm; analytical description in S and Z-domain; 3. Discrete-time description of the regulation contours; Difference equations as description of discrete control systems; Transfer functions as description of discrete control systems; Locations of poles and zeros of the discretized system; Frequency response of discrete systems. 4. Analysis of digital regulation contours: Stability of time discrete systems; Testing the stability of time discrete systems using Nyquist criterion; testing stability of time discrete systems using root-locus method. 5. Interference signals in digital regulation loops. 6. Synthesis of digital controller, and choosing the sampling period. 7. Realization of digital controllers; Structures for the realization of digital controllers.	
Literature		
Recommended	1. Lecture notes and slides (will be available at the Web site). 1. Milić Stojić, Digitalni sistemi upravljanja, Elektrotehnički fakultet, Beograd., 1998.	
Additional	2. Richard J. Vaccaro, Digital Control, McGraw-Hill, 1995. 3. Constantine H. Houps, Digital Control Systems, Mc Grow-Hill.,1985. 4. Karl J. Astrom, Computer controlled systems, Prentice Hall., 1996.	

	5. R. Iserman, Digital control system, Springer Verlag, 1981.	
Didactic methods		
	Lectures will be conducted directly in the hall and accompanied by solving the problem examples which cover course material (36 hours), in a way that enables students to acquire knowledge and skills which need to be achieved within the framework of this course. **Laboratory exercises** (11 hours), led by tutors, are designed to help students to master the software tools that allow the simulation of discrete systems and signals on digital computers, in order to check the theory explained during lectures. Also, students in the lab have the opportunity to use the digital computer in the control loop, and they should master the basic skills of digital controller implementations on a digital computer. A number of examples that accompany the lectures, and samples of exam problems, students will be solving during **the tutorial**, with the help of tutors (13 hours).	
Assesment		
	During the course students earn points according to the following system: - Attending classes, exercises and tutorials: 10 points; Student with more than three absences from lectures / tutorials cannot achieve these points. - Homework in the form of Prelabs: a maximum of 8 points is divided up to 4 homeworks (2 points each) evenly distributed throughout the semester. Knowledge gained in the laboratory exercises needs to be discussed in small groups in front of the tutor at the end of the semester (2 points); - Partial exams: two partial exams, each partial exam with a maximum of 20 points; - Final oral exam that provides maximum 40 points	
Prerequisites		
	Mathematics for Engineers 3, Linear Automatic Control Systems	

Module title	Signals and Systems	
Module code	ETF AEO SS I-3560	
Programme	ETF-B ACE	
Module coordinator	Dr Melita Ahić-Đokić, Full Professor	
Teaching staff	Dr Melita Ahić-Đokić, Full Professor Emir Sokić, MSc, Senior Teaching Assistant	
Year of study	3	
Semester	5	
Module type	Mandatory	
ECTS	5	
Lectures	36	
Laboratory exercises	8	
Tutorials	16	
Workload – Independent Study	65	
Module outcomes		
	The students acquire necessary basic knowledge about classify Discrete and continuous-time signals and LTI systems within the scope which is accepted at the most of universities throughout the world. Applying the method of transformation the signals as time functions into the adequate functional	

	domain, the analyzing of the effect of the system used for transmission on the signal transmitted is presented to the students by using the related mathematical operations. In this way, the students achieve fundamental engineering skills, knowledge and competence needed to make an approach to the analysis, synthesis, definition and resolution of the essential problems in practice, which will provide the access to the methodologies relevant for understanding of mathematical basis for contemporary systems, used for digital performance and transmission of signals.	
Module content		
	1. **Discrete-time signals and systems:** Basic sequences and Sequence operations. Discrete LTI systems, Properties of LTI systems, Impulse response and system function. 2. **The z-Transform:** Definition of the z-transform. Region of convergence for z-transform, Z-transform properties, Inverse z-transform. Implementation of the z-transform. Unilateral z-transform. 3. **F.T. discrete-time signals:** Definition of the DTFT, Properties of the DTFT. 4. **Continuous-time signals and systems:** Classification of continuous-time signals, Basic continuous-time signals, Continuous linear time-invariant systems (LTI), Properties of LTI systems, Impulse and frequency response, Systems block diagram representation. 5. **Approximation of the continuous signals:** Signal approximation by set of real and complex signals. Orthogonal representation of signals. Haar and Walsh set of orthogonal functions. 6. **Spectral analysis of periodic signals:** Representations of periodic signals with Fourier Series**,** Graphic representations of spectrum, Spectrum of real signals, Properties of F.S. continuous-time signals, Transmission of periodic signals trough LTI systems, Ideal low pass filter, Average power of a periodic signal power variation during transmission trough LTI systems, Properties of F.S. 7. **Fourier Transform:** The continuous-time F.T. Fourier transform pair, Impulse response and frequency response, Properties of the F.T. and F.T. of some basic signals, Hilbert transform, Analytic function, Amplitude modulation and single-sideband modulation (SSB). 8. **Amplitude impulse modulation:** Periodic sampling of continuous time signals, Frequency domain representation of sampling, Sampling theorem, Reconstruction of a bandlimited signal from its samples, Spectral sampling. 9. **Discrete Fourier Transform (DFT):** Fast Fourier transform (FFT), Decimation in time, Decimation in frequency, Implementation of the DFT, Compare z-transform, DTFT and DFT.	
Literature		
Recommended	1. Melita Ahić-Đokić: „Signali i sistemi“, Elektrotehnički fakultet u Sarajevu, 2010.	
Additional	1. Alan V. Oppenheim, Alan S. Willsky: “Signals and systems”, Prentice Hall, 1997. 2. B.P. Lathi: „Linear Systems and Signals“, Oxford University Press, 2004 3. Sanjit K. Mitra: «Digital Signal processing», McGraw Hill, 2002.	
Didactic methods		
	Lectures will be conducted in the class-room and accompanied by solving the problem examples which cover course material (36 hours), in a way that enables students to acquire knowledge and skills which need to be achieved within the framework of this course. **Laboratory exercises** (8 hours) led by tutors, have a goal to enable students to practically test their knowledge gained during the lectures using	

	Matlab (signal Processing Toolbox). F.T: and Spectral analysis of signals, approximation by set of signals and Representations of periodic signals with F.S:, Sampling theorem and aliasing, modulation and other terms are illustrated in examples processing sound signals, as a processing standard signals available in electronics laboratory using spectral analyzer and generator of functions. A number of examples that accompany the lectures, and samples of exam problems, students will be solving during **the tutorial**, with the help of tutors (16 hours).	
Assessment		
	During the course students earn points according to the following system: - **Attending classes, exercises and tutorials:** 10 points; (10 hours x number of hours of attendance)/ 60 hours. - **Homework** in the form of Prelabs: a maximum of 8 points is divided up to 4 home works (2 points each) evenly distributed throughout the semester. Knowledge gained in the laboratory exercises needs to be discussed in small groups in front of the tutor at the end of the semester (2 points); - **Partial exams:** two partial exams, each partial exam with a maximum of 20 points; - **Final oral exam** that provides maximum 40 points.	
Prerequisites		
	Mathematics for Engineers 3, Linear Automatic Control Systems	

Module title	Logical Systems Design	
Module code	ETF AEO PLS I-3560	
Programme	ETF-B ACE	
Module coordinator	Dr Melita Ahić-Đokić, Full Professor	
Teaching staff	Dr Melita Ahić-Đokić, Full Professor Dušanka Bošković, MSc, Senior Teaching Assistant	
Year of study	3	
Semester	5	
Module type	Mandatory	
ECTS	5	
Lectures	42	
Laboratory exercises	18	
Tutorials	0	
Workload – Independent Study	65	
Module outcomes		
	In this modul the students acquire necessary basic knowledge about tabular and graphic minimization methods simplification of logic function and combinational logic design with SSI and MSI. The purpose of this course is to introduce the students to principles of designing of the logic-sequential circuits composed of combinational elements such as electronic gates and single-bit memory elements such as flip-flops. Special emphasis is put on students skills in transition from regular text, for specific problems, to graphic or table way of presenting the logic-sequential circuits and their synthesis. A clear understanding of the principles of design problems the students achieve fundamental engineering skills, knowledge and	

	competence needed to make an approach to the definition, analysis and synthesis of the essential problems in practice.	
Module content		
	1. **Number systems and codes;** 2. **Logic functions and circuits:** Classification of logic functions, Basic logic circuits; Symbols of logic circuits, Combinational logic design with SSI; 3. **Minimization of logic functions:** Canonical and standard forms of logic functions, minimal form (minterm and maxterm), The Quine and McCluskey tabular simplification method; 4. **Graphic minimization methods of logic function:** Veitchovi maps for simplification of logic functions, The inverse function, Simplification of „don`t care" terms, Simplification of multiple output circuits, Code converters; 5. **Combinational logic design with MSI**: Multiplexers, Demultiplexers, Decoders, Parity generators, Comparators; 6. **Principles of the designing logic-sequential circuits**: Single-bit memory elements: R-S flip-flop, J-K flip-flop, D flip-flop, T flip-flop, Moore and Mealy state machines, State reduction, Clock-driven sequential circuits, Design procedure clock-driven sequential circuits.	
Literature		
Recommended	1. Lecture notes and slides (will be available at the Web site). 2. Melita Ahić-Đokić: Logički dizajn, Elektrotehnički fakultet u Sarajevu, 2006.	
Additional	1. Ridhard S. Sandige: "Modern Digital Design" McGraw-Hill Publishing Company, 1990. 2. John F. Wakerly „Digital Design, Principles & Practices" Prentice HallXilinx Design Series, 2001. 3. B. Holdsworth: "Digital Logic Design" Butterworth-Heimann Ltd 1993.	
Didactic methods		
	Lectures will be conducted directly in the class-room and accompanied by solving the problem examples which cover course material (42 hours), in a way that enables students to acquire knowledge and skills which need to be achieved within the framework of this course. **Laboratory exercises** (18 hours), led by tutors, have a goal to enable students to test their knowledge gained during the lectures using Electronics Workbench (The electronics lab in a computer). Exercises are organized so that each student has a PC at his/her disposal to perform assumed activities. Part of laboratory exercises will be performed in electronics laboratory.	
Assessment		
	During the course students earn points according to the following system: - Attending classes, exercises and tutorials: maximum of 10 points; (10 hours x number of hours of attendance)/ 60 hours. - Tests: maximum of 10 points divided up to 5 tests (2 points each) evenly distributed throughout the semester; - Laboratory exercises: maximum of 10 points; - Written exam: maximum of 30 points; - Final oral exam: maximum of 40 points.	
Prerequisites		
	Digital Electronics, Digital Integrated Circuits	

Module title	Lab Work in Automatic Control	
Module code	ETF AEI PA I-3560	

Programme	ETF-B ACE	
Module coordinator	Dr Samim Konjicija, Assistant Professor	
Teaching staff	Dr Samim Konjicija, Assistant Professor Nedim Osmić, MSc, Senior Teaching Assistant Emir Sokić, MSc, Senior Teaching Assistant	
Year of study	3	
Semester	5	
Module type	Elective	
ECTS	5	
Lectures	15	
Laboratory exercises	36	
Tutorials	9	
Workload – Independent Study	65	
Module outcomes		
	Course objective is to enable students to use microcomputer systems based on microcontrollers and their use in control. After successful completion of the course, students will have following competences: • knowledge of architecture, instruction set and specific peripheral modules of a typical microcontroller, • knowledge of specificities and procedure of application development in assembler and higher programming languages for systems based on microcontroller, • ability to develop a system based on microcontroller, used to solve a control problem, • ability to implment control algorithms on a microcontroller based system, • skills and knowledges necessary for documenting procedures and results.	
Module content		
	1. Architecture of a typical microcontroller: CPU, memory types, input/output devices. 2. Instruction set of a typical microcontroller: RISC and CISC, arithmetic-logic instructions, program flow control instructions, instructions specific for realization of embedded systems. 3. Input/output modules of a typical microcontroller: digital inputs/outputs, analog inputs/outputs, PWM, counters, timers, EEPROM for permanent storage of data as input/output module. 4. Communication in embedded control systems: serial communication and standards, RS-232, RS-485, RS-422, SPI, I^2C, Ethernet. 5. Defining hardware and software component of a control system based on microcontroller: specification of requirements, hardware development, implementing control algorithms in assembly language and higher level programming languages (C). 6. Interrupts: Use of interrupts in realization of control algorithms in discrete time. 7. Realization of project assignment: project assignment on chosen topic covered by the course.	
Literature		
Recommended	1. Notes and slides from lectures (web site) 2. M. Kurić, S. Konjicija, A. Akšamović: Praktikum automatike, skripta, ETF	

	Sarajevo, 2011. 3. M. Verle: PIC mikrokontroleri, Mikroelektronika, 2008.	
Additional	1. Dogan Ibrahim, 'Microcontroller-Based Temperature Monitoring and Control' 2. Qing Li, Caroline Yao, 'Real-Time Concepts for Embedded Systems'	
Didactic methods		
	Course is performed in form of lectures and laboratory exercises. During lectures, the students get acquainted with topics covered by the course, as well as with assignments for laboratory exercises. Students realize assignments in teams consisting of a couple of students, where formalization of procedures of teamwork is in focus. Based on explanations of laboratory exercises, the students preprare their solutions, which they realize during laboratory exercises, whereby they individually study additional literature needed for successful solution of the assignment. Each laboratory exercise consists of several sessions. After successful completion of the assignment, the students hand over a written report, and present results. In the second part of semester, the students get a project assignment, where they solve more complex problem. The project implies design of hardvare and software of an appliance, and a formal approach is obligatory. Each design step should be adequately documented, following the recommendations and requirements elaborated during lectures.	
Assesment		
	The Assessment of students' work is as follows: • Attendance to lectures and laboratory exercises (max. 10 points). Student with more than three absences from lectures and laboratory exercises can't get these points. • Two partial exams (max. 2x20 points). • Preparation for laboratory exercises and presentation of results (max. 10 points). • Realization of final project (max. 15 points). • Final exam (max. 25 points). During semester, the students take two written partial exams, where they solve the problems covered by the topics of the course. A student with less than 10 points on a partial exam takes remedial exam. During the final exam, the students answer questions from topics covered by the course, and demonstrate solving simpler versions of problems similar to those from laboratory exercises. In order to pass the exam, a student has to collect min. 55 points, including: attendance, preparations and defense of laboratory exercises and project, partial exams and final exam.	
Prerequisites		
	Fundamentals of Computing, Digital Electronics	

Module title	Lab Work in Electronics	
Module code	ETF AEI PE I-3560	
Programme	ETF-B ACE	
Module coordinator	Dr Abdulah Akšamović, Associate Professor	
Teaching staff	Dr Abdulah Akšamović, Associate Professor Alvin Abdagić, MoE, Teaching Assistant	
Year of study	3	
Semester	5	
Module type	Elective	

ECTS	5	
Lectures	15	
Laboratory exercises	36	
Tutorials	9	
Workload – Independent Study	65	
Module outcomes		
	Upon successful completion of this course, students should be able to: independently design circuits based on 8-bit microcontrollers; use an integrated development environment (IDE) to: write both assembler and C code, debug, test the application through simulation, program the actual device, and test the actual hardware. Students are introduced to the principles of operation of a RISC processor, elements of its architecture, intergraded peripheral devices (A/D converters, EEPROM, basic communication - RS232, RS485). Through the work on the project assignment, students get acquainted with principles of designing and building the necessary hardware, S/H co-design, making proper documentation, and are given a chance to express their creativity.	
Module content		
	Application specific microcontroller-based systems. 8-bit microcontrollers. RISC processors, inctructions set. Integrated perhiperals: ADC, PWM, WDT, timers, ISP, EEPROM. Microcontrollers programs design cycle. Integrated development enviroment: assembler and assembly language, C-compiler, debugger, simulator, programmer. Serial communication: RS232, RS485, I2C, USART. Interrupts. Realization of a binary counter. Generating a siginal using the microcontroller. Using ports: inputs and outputs. Using analog inputs. Realization of the communication between a microcontroller and a PC, and also between two microcontrollers. Project assignment in teams of up to four students.	
Literature		
Recommended	1. Slides and lecture notes (available at the courseware) 2. Qing Li, Caroline Yao, *Real-Time Concepts for Embedded Systems* 3. Dogan Ibrahim, *Microcontroller-Based Temperature Monitoring and Control*	
Additional	1. Anil K. Maini, *Digital Electronics - Principles, Devices and Applications*, John Wiley & Sons Ltd, 2007 London	
Didactic methods		
	This course is thought through introductory lectures in aula, organized for all students in the duration of two classes for each topic (in total of 15 classes). These lectures allow students to prepare for labs. Split in groups, they attend the labs in an electronics laboratory for the total duration of 36 classes. All the work in labs is performed in groups od two. The obtained results, along with work done as the prepartion for the labs is submitted as a report which is then evaluated. During the tutorials, students with the help of a teaching assistant solve tasks in assembly language for an actual microcontroller. During the second half of the semester, students work on a project assigment in groups of up to four.	
Assessment		
	Through the duration of the course, points are accumulated as follows: • attendance to all classes: up to 10 points; • work in the labs: up to 10 points; • first partial exam: up to 20 points;	

	• second partial exam: up to 20 points; • project assigment: up to 40 points.	
Prerequisites		
	Digital Electronics	

Module title	Operating Systems	
Module code	ETF AEI OS I-2360	
Programme	ETF-B ACE, CI	
Module coordinator	Dr Samir Ribić, Assistant Professor	
Teaching staff	Dr Samir Ribić, Assistant Professor Alvin Huseinović, MoE, Teaching Assistant	
Year of study	2	
Semester	3	
Module type	Mandatory	
ECTS	5	
Lectures	38	
Laboratory exercises	22	
Tutorials	0	
Workload – Independent Study	65	
Module outcomes		
	After successful completion of the course, student will be able to: • Identify the major components of an operating system and explain their functions individually. • Discuss the operating system features required for a particular target application. • Understand the various levels of system and application software. • Get familiar with the major Operating System services such as file systems, memory management, process management, device control and user interface. • Understand how design decisions in Operating Systems affect users of the system. • Use and modify operating systems.	
Module content		
	1. Introduction: Role, functions and structure of operation system, historical development of operation systems: batch, multiprogramming, time sharing. 2. Structure of computer system, interrupts and interrupt management, input-output operations, dual mode of processor work. 3. Structure of operating system: layered structure of operation system, monolithic and microkernel, functional organization of UNIX operation system. 4. Resource management, I/O manager, methods for stoppage management, banker's algorithm. 5. Process management: Concept and condition of processes context switching, operation over processes, process representation, threads and thread management, process management in UNIX/Windows, inter-process communication using message transfer: direct, indirect, buffering, usage of pipes and signals. 6. Shared memory usage: process synchronization problem, critical section and mutual exclusion, semaphores and hardware techniques for	

	synchronization: test and set. 7. Processor scheduling: General concepts and criteria of distribution, dispatcher scheduling algorithms: FCFS, SJF, priority, Round Robin, MFQ, scheduling examples from UNIX and WINDOWS operation systems. 8. Memory management: Loaders, general concepts address translation from logical to physical, memory allocation, continual: with one or more partitions, static and dynamical and non-continuous: paging and segmenting, virtual memory, memory management in UNIX. 9. File management: Structures of file system, free space management, file and directory implementation, file systems in Unix and Windows operation systems: logical organization of files, file/directory access management, file protection. 10. User interface, textual, graphical and network. 11. DOS, Windows and Linux system architecture, using customizing i and participating in development of Linux systems.	
Literature		
Recommended	1. Slides and lecture notes available at web page and in printed form 2. Silberschatz A., "Operating System Principles", 7th Edition, Addison Wesley, 2006.	
Additional	1. Ribić S, "Linux distribucija BHLD", priručnik, Elektrotehnički fakultet u Sarajevu, 2011. 2. Đorđević B., Pleskonjić D, Maček N, "Operativni sistemi, teorija, praksa i rešeni zadaci", Mikro knjiga, Beograd 2005. 3. Tanenbaum A., "Modern Operating Systems", 3rd Edition Prentice Hall, 2008. 4. Stallings W., "Operating Systems: Internals and Design Principles,", 6th Edition, Prentice Hall, 2009.	
Didactic methods		
	Lectures, self-usage of literature, numerical problem solving, practical usage of operating systems The lectures include basic operating systems principles. The students are informed about different kernel subsystems and their relationships. In addition to basic principles of the operating systems, the lectures include quantitative principles that illustrate introduced concepts and algorithms. The labs include workings with operating systems from user and system perspective. The homework might include additional examples and problems closely related with lectures or contributions in open source OS development. Therefore labs and home works contribute to students competencies of operating systems understandings and competences for usage and customizing of operating systems.	
Assesment		
	The final score is obtained as follows: • 10 points for attendance and activities during lecture and laboratory exercises • 10 points for homeworks. The students choose beween problem-solving assignments or group project in development of local operational systems • 20 points first partial written exam, problem solving, 10 points is considered pass • 20 points second partial written exam, problem solving, 10 points is considered pass • 40 points and a final oral exam (where 15 points is considered passed the exam), checking the facts. Only the students who have achieved the above criteria by at least 40 points can participate. Students who did	

	not pass required parts of the course have two chances for remedial exam. Final score: Below 20 points retake course, score 21-54 grade 5, score 55-64 grade 6, score 65-74 grade 7, score 75-84 grade 8, score 85-94 grade 9, score 95-100 grade 10.	
Prerequisites		
	Fundamentals of Computing	

Module title	Software Development	
Module code	ETF AEI RPR I-3560	
Programme	ETF-B ACE, CI	
Module coordinator	Dr Dženana Đonko, Associate Professor	
Teaching staff	Dr Dženana Đonko, Associate Professor Teo Eterović, MoE, Teaching Assistant	
Year of study	2	
Semester	3	
Module type	Mandatory	
ECTS	5	
Lectures	38	
Laboratory exercises	22	
Tutorials	0	
Workload – Independent Study	65	
Module outcomes		
	At the end of this course students have the following knowledge, skills and competencies: • Ability to identify and define the requirements of simple systems that require computational support • Ability to implement parts of computer based systems, including programming of the necessary solutions • The ability to apply an iterative software development process • Understanding of basic and advanced object-oriented concepts • The ability of the individual organizing and implementation of the parts of the project • The ability to design and implement graphical user interfaces and event driven programming • Practical knowledge of .NET Framework and. NET languages • The ability to implement threads	
Module content		
	1. Advanced concepts of object-oriented programming. 2. Principles and methods of organizing and decomposition of projects / programs. 3. Software environments-introduction to software framework, .NET framework and the C-based programming languages. 4. The basic principles of object-oriented design-design for simple systems. 5. Graphical user interface (GUI) - basic GUI controls and components. 6. Event driven programming. 7. Human-computer interaction, the principles of good design of graphical user interfaces.	

	8. Design and implementation of graphical user components. 9. Exception handling: techniques of error handling, exception handling mechanisms in the object-oriented languages. 10. Programming of persistent data manipulation. 11. Multithreading.	
Literature		
Recommended	1. Notes and slides from lectures (See Faculty WEB Site) 2. Ivor Horton , Beginning Visual C++ 2010, Wrox, 2010. 3. Jeff Johnson, Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules, Morgan Kaufmann, 2010.	
Additional		
Didactic methods		
	Theoretical concepts related to these topics are presented during the lectures. The presented concepts are illustrated by examples and they are discussed along with the students. Throughout the semester students will be getting homework that is thematically consistent with the lectures and tutorials related to the implementation of software components of simple systems. Concrete tasks related to the course and continuous monitoring of homework will be worked on in the lab.	
Assessment		
	During the course student earns points according to the following system: • attending classes and tutorials: 10 points, the student with more than three absences from lectures and/or exercises cannot get these points; • homework: maximum of 25 points; assuming solving up to 5 assignments equally distributed throughout the semester; • partial exams: two partial exams, each partial exam earns a maximum of 20 points (pass mark is 10 points and more); exams are composed of a theoretical part and a practical part that is done on the computer. • oral exam: maximum 25 points, consisting of questions related to the course thematic units. A student who does not pass the partial exams has to retake an exam. Final grade is made on the basis of points collected for all activities during the semester, based on the scale: • 96-100 grade 10 • 86-95 grade 9 • 76-85 grade 8 • 66-75 grade 7 • 55-65 grade 6	
Prerequisites		
	Programming Techniques	

Module title	Structures and Operational Modes of Electrical Power Systems	
Module code	ETF AEO SES I-3660	
Programme	ETF-B ACE	
Module coordinator	Dr Sead Kreso, Associate Professor	
Teaching staff	Dr Sead Kreso, Associate Professor Emir Fočo, MSc, Senior Teaching Assistant Almir Salihbegović, Teaching Assistant	
Year of study	3	
Semester	6	
Module type	Mandatory	

ECTS	5	
Lectures	33	
Laboratory exercises	18	
Tutorials	9	
Workload – Independent Study	65	
Module outcomes		
	Throughout the course, students learn about the basic elements of the electrical power system, as well as the structure and operation of power systems.	
Module content		
	1. Introduction to the control of electrical power system 2. Power flows in the electrical power system; The formulation of the problem; General system equations; Newton Rhapson method; Variables separation method. 3. Topology and structure of electrical power networks: Basic scheme of transmission and distribution networks. 4. Generators, operation modes, equivalent schemes and short-circuit of generators. 5. Transformers: types and connections of transformers, equivalent scheme and transformer parameters. 6. Transmission lines: classification, the parameters of transmission lines. 7. Consumer nodes: electric motors, capacities and inductances. 8. Normal operation mode of the electrical power system: loss of power and energy in the electrical power system, the power factor correction, switch-on and switch-off of transformers in parallel operation mode. 9. Disturbed mode of electrical power system: current overload, unbalance load, voltage deviation, the opposite direction of power, increse temperature of system elements. 10. The automation devices in electrical power system: voltage and frequency control, generator excitation controller, voltage control modifying network parameters, compensation of reactive power. 11. Short circuits in the electrical power system, neutral grounding and types of failures, short circuit protection.	
Literature		
Recommended	1. Lecture notes (can be seen at the Faculty Web Page) 2. A.S.Debs: "Modern Power Systems Control and Operation" Kluwer Academic Publishers	
Additional	1. Fabio Saccomano “Electric Power Systems- Analysis and Control”, John Wiley and Sons Inc , NJ. 2003.	
Didactic methods		
	The lectures will be conducted directly in the hall and accompanied by solving the problem examples which cover course material, in a way that enables students to acquire knowledge and skills which need to be achieved within the framework of this course. **The laboratory exercises**, led by tutors, are designed to help students to master the software tools that allow validation of the theoretical fundamentals of the electrical power system. With the help of tutors, students will be solving during **the tutorial,** a number of examples that accompany the lectures, and samples of exam problems.	
Assesment		
	During the course students collect points according to the following system:	

	- Attending classes and tutorials: 10 points. Student with more than three absences from lectures and tutorials can not collect these points, - Homework and lab exercises: maximum of 10 points is supposed to make up to 5 homework - Partial exams: two partial exams, each positively evaluated partial exam maximum 20 points - Seminar to 16 points, and added only oral depositing items, - Oral examination (maximum 24 points) includes an oral test of understanding theoretical concepts.	
Prerequisites		
	Fundamentals of Electrical Engineering, Electrical Circuits 1, Electrical Circuits 2	

Module title	Mechatronics	
Module code	ETF AEO ME I-3660	
Programme	ETF-B ACE	
Module coordinator	Dr Jasmin Velagić, Full Professor	
Teaching staff	Dr Jasmin Velagić, Full Professor Nedim Osmić, MSc, Senior Teaching Assistant	
Year of study	3	
Semester	6	
Module type	Mandatory	
ECTS	5	
Lectures	42	
Laboratory exercises	18	
Tutorials	0	
Workload – Independent Study	65	
Module outcomes		
	Gaining basic knowledge on mechatronic components and their synergistic integration into system. Students who successfully acquired theoretical part presented through lectures, laboratory exercises and independently solved seminar work should be enabled to solve complex problems related to design, verification, validation and testing of mechatronic components and systems.	
Module content		
	1. Definition of mechatronics, historical development of mechatronic systems. Mechatronic systems, architectures, functions, applications and ways of integration. Future directions of mechatronics development. 2. Mechatronic system design: V-design. Design of mechanical and electronic components. Design of electronic control unit (ECU). Real-time simulation. Rapid Control Prototyping (RCP). Hardware in the loop (HIL). Verification and validation of controller performance. 3. Control of electromotor drives. Multi-loop control (cascade control). Technical and symmetrical optimum. Application of technical and symmetrical optimum in control of DC motor system supplied by thyristor converter. 4. Requirements for implementation of control algorithms. Software control. Microprocessor based control. Microcontrollers, programmable logic controller (PLC) and microprocessor based control	

	boards. Embedded computers and controllers. Architectures of microprocessor based systems, their properties and ways of communications. 5. Approaches for determining the position and orientation. Measurements of absolute and relative position. Working principle of position sensors. Encoders and infrared sensor. Rangefinder sensors (laser and ultrasonic). Inertial and global positioning sensors. 6. Robot systems, industrial and mobile robots. Types of robots, justification of their usage and application. Ways and mechanisms of mobile robot locomotion. Robot tasks and their solving. Modeling and control of robot systems. 7. Automotive mechatronic systems. Active and passive suspension systems. Modeling of suspension system and analysis its behavior in state space. Electro-hydraulic and Electro-mechanical brake systems. Design of controller for electro-hydraulic break system. Steering system. Estimation of steering system parameters (RLS observer). Adaptive control of actuator. Fault tolerant systems and analysis. 8. Intelligent control of mechatronic systems. Fuzzy control systems and design of fuzzy controller. Fuzzy control of DC motor. Neural network based control. Design of neural network based controller. System identification.	
Literature		
Recommended	1. Notes and slides from lectures (See Faculty WEB site). 2. R.H. Bishop, *Mechatronics Handbook*, CRC Press, Boca Raton, 2002. 3. R. Isermann, *Mehatronic Systems Fundamentals*, Springer Verlag, Berlin, 2003. 4. D.G. Alciatore and M.B. Histand, *Introduction to Mechatronics and Measurement Systems*, McGraw-Hill, New York, 2003.	
Additional	1. D. Shetty and R.A. Kolk, *Mechatronics System Design,* PWS Publishing, Massachusetts, 1997. 2. D. Necsulescu, *Mechatronics*, Prentice-Hall, NJ, 2002.	
Didactic methods		
	Direct lectures are performed in an aula and they are supported by stating and solving of problems done by the lecturer with aim to enable students to adopt methods introduced during lectures. Making students studying the literature independently and searching for problems and analyzing of examples. Seminar work independently solved by students. Laboratory exercises in which students directly apply concepts of analyzing, verification and testing presented during lectures.	
Assesment		
	The grading of the course is as follows: - Attending classes: max. 10 points, - Laboratory exercises: max. 20 points, - Seminar work: max. 40 points, - Final exam: max. 30 points.	
Prerequisites		
	Actuators, Sensors and Measurements, Linear Automatic Control Systems	

Module title	Robotics 1	
Module code	ETF AEI RO I-3660	
Programme	ETF-B ACE	
Module coordinator	Dr Jasmin Velagić, Full Professor	

Teaching staff	Dr Jasmin Velagić, Full Professor Bakir Lačević, Assistant Professor Emir Sokić, MSc, Senior Teaching Assistant Dinko Osmanković, MoE, Teaching Assistant	
Year of study	3	
Semester	6	
Module type	Elective	
ECTS	4	
Lectures	39	
Laboratory exercises	16	
Tutorials	5	
Workload – Independent Study	65	
Module outcomes		
	• Acquired fundamental knowledge from forward and inverse kinematics and dynamics of robotic manipulators, • Capability to conduct robot motion planning to execute the given task, • Acquired knowledge of a variety of control algorithms dedicated to control of robotic manipulators, • Ability to implement path planning and control algorithms within a simulation environment, • Ability to implement a planned motion using a real industrial robotic manipulator.	
Module content		
	1. Introduction to robotics. Robotic applications. Structure and classification of robotic manipulators. 2. Kinematics of robotic manipulators. Coordinate transforms. Representation of position and orientation of a rigid body. Rotation matrix. Minimal representation of orientation. Euler's angles. 3. Homegeneous transform. Forward kinematics. Denavit-Hartenberg parameters. Examples of solution to forward kinematics problem. 4. Principles of inverse kinematics problem. Examples of solution to inverse kinematics problem. 5. Differential kinematics. The notion of Jacobian. Computation of geometric and analytical Jacobian. Singularities. Application of Jacobian in robotics. 6. Dynamics of robotic manipulators. Newton-Euler approach to modeling. Approach based on Lagrange equations. 7. Motion planning for robotic manipulators. Planning in joint space. Planning in operational space. 8. Control of robotic manipulators. Decentralized control. Centralized control. 9. Interaction control. Basics of intelligent control in robotics.	
Literature		
Recommended	1. Jasmin Velagić - Analysis and Control of Robot Manipulators, University Book, Mostar, 2008. 2. B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo - Robotics – Modelling, Planning and Control, Springer, 2009. 3. Mark W. Spong, Seth Hutchinson, M. Vidyasagar - Robot Modeling and Control, Wiley, 2006.	
Additional		

Didactic methods		
	Lectures have a goal to provide a comprehensive overview of all the course modules. Lectures are performed in an aula in a manner which enables students to easily follow the course and immediately spot notions and methods that seem less clear to them. After completing each module of the course program, the lecturer demonstrates examples that enable students to master the terminology, instruments and methodology presented during lectures. Additional examples and problems are considered and solved during laboratory exercises and tutorials (under the guidance of a tutor – teaching assistant).	
Assesment		
	During the semester, students collect points according to the following system (max **100** points): **-Attendance: 10 points** Students who fail to attend lectures and/or lab exercises more than three times cannot obtain these 10 points. **- Partial exams: max 2 x 20 = 40 points.** Two written partial exams are scheduled: one at the middle of semester, and another at the end of semester. The second partial exam can be replaced by a small project or seminar work. **-Lab exercises reports and homework assignments: max 10 points** After lab exercises, a student writes the report. The report contains the results and comments of tasks conducted during the lab excercise. The report can possibly contain results and comments on additional homework assignments. A student who failed to collect 20 points or more during the semester must take the course again. **-Final, oral exam: max 40 points** A student who achieves 40 points or more can take a final, oral exam. This exam includes a discussion on any topic covered within lectures or lab exercises. A student who achieved 20 points or more, but less than 40 points can take a make-up exam. A make-up exam is structured in the following way. A written part (or a report on the results of the project) is organized in the same way as a partial exam for which the student failed to obtain a positive grade. An oral part is organized in the same way as the oral part of the regular oral exam and is also graded by maximum of 40 points. A student who accumulated 40 points or more from attendance, lab reports and written make-up exam may take a make-up oral exam.	
Prerequisites		
	Modeling and Simulation, Linear Automatic Control Systems	

Module title	Fluid Dynamics and Thermal Systems	
Module code	ETF AE DF I-3650	
Programme	ETF-B ACE	
Module coordinator	Adnan Tahirović, Assistant Professor	
Teaching staff	Adnan Tahirović, Assistant Professor Mehmed Brkić, MoE, Teaching Assistant	
Year of study	3	
Semester	6	
Module type	Elective	
ECTS	4	
Lectures	32	

Laboratory exercises	0	
Tutorials	18	
Workload – Independent Study	50	
Module outcomes		
	After completing the course, students are supposed to be capable of: 1. Understanding some basics of fluid mechanics, thermodynamics and heat transfer for the purpose of design of control systems. 2. Deriving some basic equations that can be used to describe fluid dynamics, thermodynamics and heat transfer. 3. Modeling of physical processes and variety of phenomena that may arise in the field of fluid mechanics, thermodynamics and heat transfer.	
Module content		
	1. **Fluid mechanics:** Fluid properties, fluid statics, fluid pressure, lift; control volume analysis; differential equations for mass and momentum conservation, Bernoulli equation, viscous flow of compressible fluid; boundary layer; turbulent flow; pipe flow, pressure drop through a pipe. Velocity and pressure measurements, flow measurement, measurements within compressible fluid, measurement accuracy. 2. **Heat transfer:** Models of heat transfer; one-dimensional heat conduction, concept of resistance, electrical analogy, nonstationary heat conduction. Nondimensional parameters, convective heat transfer, correlations for heat transfer in the flow over a flat plate and through the pipes; Thermal boundary layer; Consequences of turbulence; Heat transfer by radiation, blackbody and gray surfaces, shape-factor, analysis of a network; Heat exchangers, the log mean temperature difference and NTU (the number of transfer units). 3. **Thermodynamics:** Thermodynamics laws (zeroth, first and second); Thermodynamic systems and processes, Carnot cycle; Irreversibility and availability; Behavior of ideal and real gases, properties of pure substances, work calculation and heat for ideal processes; Analysis of thermodynamical cycles for energy conversion; Humid air, psychrometric diagrms, basics of psychrometric processes. 4. **Applications:** *Energy sector*: Vapor tables and diagrams, Rankine and Brayton cycles with regeneration. Internal combustion engine: Otto and Diesel cycles. Cooling devices and heat pumps: Vapor cycle cooling systems, reverse Brayton cycle.	
Literature		
Recommended	1. Lecture notes and slides 2. Šikalo, Š. 2009. *Termodinamika i molekularni transportni procesi*, Dobra knjiga, Sarajevo. 3. Ganić, E.N. 2005. Prenos toplote i mase, Svjetlost, Sarajevo.	
Additional	1. Demirdžić I. 1990. *Mehanika fluida – I dio Osnove*, Mašinski fakultet u Sarajevu, Sarajevo. 2. Moran, M.J, Shapiro, H.N. Munson, B.R., DeWitt, D.P. 2003. *Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer*, John Wiley & Sons, New York. 3. Kaminski, D.A., Jensen, M.K., 2005 *Introduction to thermal and fluid engineering*, John Wiley & Sons, New York.Thomas L. Floyd, 'Electronics Devices', Prentice Hall 2012.	
Didactic methods		

	Lectures are performed in an aula for all students. Besides presenting the appropriate theoretical content, lectures are used to illustrate the usage of some numerical tools and to present a variety of theoretical phenomena related to the field of fluid dynamics and thermal systems. In addition, the purpose of the tutorial part of the course presentation is to demonstrate some illustrative numerical examples to facilitate understanding of the course subject.	
Assesment		
	During the semester, students collect points according to the following system (max **100** points): -Attendance: 10 points, - Partial exams: max 2 x 20 = 40 points, -Lab exercises reports and homework assignments: max 10 points, -Final, oral exam: max 40 points.	
Prerequisites		
	Mathematics for Engineers 1, Physics for Engineers 2	

Module title	Power Electronics	
Module code	ETF AEI EE I-3660	
Programme	ETF-B ACE	
Module coordinator	Dr Nijaz Hadžimejlić, Associate Professor	
Teaching staff	Dr Nijaz Hadžimejlić, Associate Professor Senad Huseinbegović, MSc, Senior Teaching Assistant Adnan Ahmethodžić, Teaching Assistant	
Year of study	3	
Semester	6	
Module type	Elective	
ECTS	4	
Lectures	39	
Laboratory exercises	11	
Tutorials	10	
Workload – Independent Study	40	
Module outcomes		
	-basic engineering knowledge on analysis, synthesis, defining and solving problems in semiconductor converter domain; -ability to determine approach and apply specific engineering principles, mathematical and computer methods for solving problems in semiconductor converters domain; -one is prepared for industrial requirements in his professional engagement	
Module content		
	Basic working principles of power converters. Functional characteristics of semiconductor converters. Power accumulation elements, their role in power converters. Volt-second and ampere-second balance. Basic dc-dc converters analysis:buck, boost, buck-boost. Single quadrant, two and four quadrant converters. Independent inverters. Pulse width modulated voltage inverters. Resonant inverters. Natural commutation converters. Single-phase and multi-phase rectifiers, Network guided inverters. Commutation in converters.	

	Mathematical description of converters. State variables. Steady state and converter dynamics. Averaging methods. Work point linearization. Control systems for converters. Voltage and current control. Power supply units. Galvanically isolated converters. Uninterruptible power supply units. Industry applications of converters. Controled electric drives with dc and ac machines.	
Literature		
Recommended	1. Lecture notes and slides (available on Faculty web site); 2. Mohan, Undeland, Robbins: "POWER ELECTRONICS – Converters, Applications and Design", JOHN WILEY & SONS, INC., printed in USA 1995.	
Additional	1. J.Kasakian, M.Schlecht, G.Verghese: "PRINCIPLESS OF POWER ELECTRONICS", Addison-Wesley Publishing Company, printed in USA, 1992.	
Didactic methods		
	Theoretical lectures and problem solving performed in lecture-hall by the lecturer (39 classes). Solving problems of analysis and synthesis of semiconductor converters. The aim is to enable individual students for analyzing and design od simple electronic converters. The aim od laboratory exercises (11 classes) is to show students software for modelling of electric converters. Throughout tutorials (10 classes), under guidance of tutor, using knowledge acquired in lectures, students solve problems in semiconductor converters.	
Assesment		
	Distribution of points is as follows: - Lectures and tutorial attendance is awarded with 10 points, student which is not present at three classes (any of the class forms) will not receive points on this basis; - Homework and labwork is awarded with max 10 points; 4 homework assignments, and 6 laboratory assignments will be given through semester; - Partial exams: there are two written partial exams; each positively graded partial exam is awarded with max 20 points. Duration of partial exam is 90 minutes, and it is consisted of: - Simple questions, the goal is to test students basic theoretical knowledge; max 5 points can be awarded in this part of exam; - Multiple choice questions, max 5 points can be awarded in this part of exam; - Open answer problem; max 10 points can be awarded in this part of exam; Student with less than 20 points at the end of the semester must attend the course again. Student with 40 or more points at the end of the semester takes final oral exam; this exam consists of discussing partial exams, homework and answering simple course matter questions. Final oral exam is awarded with maximum 40 points. Student must get at least 20 points to pass this part of exam. Student which does not get 20 points on it can retake final oral exam. Student with more than 20 and less than 40 points can take makeup exam. Makeup exam is consisted of: - Written part, which is basically same as the written partial exam; student retakes the partial exam which he did not pass (10 or more points) - Oral part is the same as the final oral exam. Student with more than 40 points after written makeup exam can take oral part of makeup exam; the point awarder for attendance and homework are	

	added to points from exams or makeup exams. - Final oral makeup exam is awarded with maximum 40 points. Student must get at least 20 points to pass this part of exam. Student which does not get 20 points on it must attent the course again.	
Prerequisites		
	Analog Electronics	

Module title	Design of Microprocessor Based Systems	
Module code	ETF AEO PMS I-3660	
Programme	ETF-B ACE	
Module coordinator	Dr Sead Kreso, Associate Professor	
Teaching staff	Dr Sead Kreso, Associate Professor Senad Huseinbegović, MSc, Senior Teaching Assistant	
Year of study	3	
Semester	6	
Module type	Elective	
ECTS	5	
Lectures	33	
Laboratory exercises	24	
Tutorials	3	
Workload – Independent Study	65	
Module outcomes		
	Students need to acquire the basic elements and basic knowledge related to the design of microprocessor based systems at the level of components and modules programmable logic controllers. Students have to learn the necessary skills so that can project a realistic structure that performs a specific function (lift, semaphore management, cutting stone, etc.).	
Module content		
	1. Fundamentals of microprocessor systems 2. Approach to the design of a modular microprocessor-based systems 3. Designing and addressing bus, the logic for components selection. 4. 8-bits Architecture microprocessors, their characteristics and important differences. Programmable Timers and Counters. Programmable digital inputs and outputs. 5. Parallel communication (simplex, half duplex, duplex). Asynchronous and synchronous serial communications. Programmable serial communication controller. Programmable interrupt controller. 6. Microcontroller and design of structures based on microcontrollers 7. 8-bit microcontroller and functional blocks 8. Communication microcontroller, A / D converter, analog comparator, and instruction set 9. Programmable Logic Controllers 10. Designing PLC structure 11. Designing real systems using programmable logic structure	
Literature		
Recommended	1. S.Kreso, S Huseinbegović: Projektovanje mikroprocesorskih sistema, ETF Sarajevo, 2012. 2. Bilješke i slajdovi sa predavanja (mogu se vidjeti na WEB-u Fakulteta)	
Additional	1. CD : EASY-SOFT pro (http//www.moeller.net)	

Didactic methods		
	Lectures will be conducted directly in the room (33 hours) in a way that enables students to acquire knowledge and skills to be achieved within the framework of this course. Laboratory exercises (24 hours), led by tutors, aim to provide students with a software package implemented through simulation and verification work from simple circuits to complex programmable structures. A number of tasks, students will be dealt with during the tutorial, with the help of a tutor (3 hours).	
Assesment		
	During the course students collect points according to the following system: - Attending classes and tutorials: 10 points. Student with more than three absences from lectures and / or exercise can get these points on this basis; - Homework: maximum of 10 points is supposed to make up to 5 homework. - Seminar to 16 points, and added only the oral part of the exam. - Partial exams: two partial exams, each positively evaluated partial exam scored 20 points maximum; Students who achieve 10 or more points in a partial exam pass the partial exam. A student who has achieved during the semester, less than 20 credits to enroll for this course. A student who during the semester collect 20-39 points, the makeup exam. The makeup exam is structured in the same way as the partial exam. Oral student access if the total work of the seminar collect 56 points or more. The makeup oral exam is structured in the same way as regular.	
Prerequisites		
	Digital Electronic, Digital Integrated Circuits, Design Logic Systems	

Module title	Final Thesis	
Module code	ETF AIO ZR I-36130	
Study programme	ETF-B ACE	
Responsible teacher		
Teaching Staff	Dr Melita Ahić-Đokić, Full Professor Dr Mujo Hebibović, Full Professor Dr Jasmin Velagić, Full Professor Dr Nijaz Hadžimejlić, Associate Professor Dr Sead Kreso, Associate Professor Dr Jasna Pašić, Associate Professor Dr Mustafa Musić, Associate Professor Dr Abdulah Akšamović, Associate Professor Dr Samim Konjicija, Assistant Professor Dr Bakir Lačević, Assistant Professor Dr Adnan Tahirović, Assistant Professor	
Year	3	
Semester	6	
Module type	Mandatory	
ECTS	12	
Total Workload	300	

Module goal - Knowledge and skill to be achieved by the students		
	In implementing and defending their final thesis students shall: - master their skills in solving practical problems within the scope of the study programme and by using theoretical knowledge and practical skills gained during the study - improve and demonstrate ability to search literature in the area of their studies, to interpret relevant data, to make conclusions including reflections on relevant social, scientific and ethical issues. - validate their written and oral communication skills, and ability to transfer information, ideas, and solutions in the written (final thesis) and oral form (presentation and defense of the thesis) - demonstrate ability to decompose a complex problem, to model and formally describe the problem, conduct an experiment, and write an expert technical document - demonstrate ability to perform a literature review and research independently.	
Syllabus		
	• Problem definition. Hypothesis, task, project. Literature review. Method selection. • Practical work plan. Practical work implementation (software, model, device). Conducting the experiment. Developed solution verification and validation. • Consultation, for-against debate, adopting suggestions, time planning and meeting deadlines. • Interim text version drafting. Expert and technical writing. Literature review. Citations. Methods assessment. Interpreting the results. Formal and visual results presentation. • Completing the thesis, adoption of the adviser suggestions and comments. Text editing. • Results presentation. Writing presentation. Oral presentation. Presentation techniques, time and content planning. Focus on important issues and on personal achievements. Answering questions.	
Literature		
Recommended	Defined in thesis description.	
Additional	Defined in thesis description.	
Didactic methods		
	Problem/task/project/hypothesis definition. Guidance and advising. Deadlines planning. Consultative work. Independent work. Guiding student through independent literature review. Project/software/device implementation. Technical paper writing. Validating / systematization / presenting results. Conducting experiment / simulation.	
Assessment		
	• Plan and activities for timely completion: 20 points; • Practical and implementation: 30 points; • Final thesis: 20 points; • Writing presentation: 10 points; • Oral presentation: 20 points.	
Prerequisites		