List of contents

20	Computer Aided Product Development	3	71
21	Control Theory of Nonlinear Systems	3	72
22	Discrete Time Signal Processing	3	73
23	Electrical Drives	3	74
24	Electrical Networks and Electromagnetic Fields	3	75
25	Higher Kinetics - Multibody Systems	3	76
26	Nonlinear Field Theories of Mechanics	3	76
27	Servohydraulics	3	77
28	Thermofluiddynamics	3	77
29	Control of nonlinear mechatronic systems 1	1,25	78
30	Control of nonlinear mechatronic systems 2	1,25	79
31	Modern Frequency Domain Methods in Control	1,25	79
32	Control System Technology 1	3	81
KU Leuven-Master's programme			
33	Identification and Advanced Control of Mechatronic Systems	6	82
34	Mechatronics drive systems	6	83
35	Optimization of Mechatronic Systems	6	86
36	Embedded Control Systems	3	88
37	Robotics	4	92
38	Advanced Robot Control Systems	6	95
KTH-Master's programme			
39	Advanced prototyping	6	97
40	Embedded Systems1 in Mechatronics	6	98
41	Dynamics and Motion control	9	99
42	Embedded Systems 2	6	101
43	Embedded Systems Design Project	9	103
44	Mechatronics Advanced Course part 1	9	105
45	Introduction to Engineering Design	3	108
46	MF 2043 Robust mechatronics	6	110
47	MF2030 Mechatronics basic courses	6	111

CURRICULUM ANALYSIS AT TASHKENT AUTOMATIVE ROAD INSTITUTE

Curriculum analysis for the Bachelor's program "5310700-Electromechanics and Electrotechnics" at TARI

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
1	**Basics of electronics and schematics**	At the end of the course, students will be able to understand: - Recent achievements of science and technology in electronics and schematics, new computation methods and problems; - Roles and application areas of modern electronics, microelectronics and microprocessors; - Computation and analysis methods of electrical circuits; - Applications, components and schemes of electro-technical and electronically automated devices in electronics and schematics - Essentials of electronics and schematics, methods of modern information use, preservation and collection	- Main characteristics of semiconductors - Semiconductor devices - Transistors and their types and applications - Tristors - Elements of memory disks - Integral microschemes - Semiconductor magnetic devices - Essentials of Quantum Electronics - Photo-electrical light converter and light emitter semiconductors - Opt-electronic devices.	- Semiconductor diode - Transistors - Tristors - Elements of memory disks - Integral micro-schemes - Semiconductor magnetic devices - Essentials of Quantum Electronics - Photo-electrical light converter and light emitter semiconductors - Opt-electronic devices.	- To study characteristics of semiconductor diode - To study stabilizers and their characteristics - To study semiconductor tiristors - To study characteristics of bipolar transistors - To study conversion schemes of alternative current to direct current - To study design schemes of three phase circuits.
	90		**54**	**18**	**18**

#	Talim yo`nalish nomi, shifri, fanning nomi, umumiy soati	Fanni o`rganish natijasida bo`lajak mutaxassis quyidagilarni bilish kerak	Fan bo`yicha mavzular rejasi	Amaliyot mashgulotlarining namunaviy mavzulari	Laboratoriya mashgulotlari namunaviy dastur rejasi
1	**«Elektronika va sxematexnika asoslari»**	Bu fanni o'qigandan keyin talabalar quyidagilarni bilishlari kerak: -Elektronika va sxematexnika asoslari sohasidagi fan-texnika va texnologining eng so`ngi yutuqlari, yangi hisoblash usullari va muammolari haqida; -Zamonaviy elektronika, mikroelektronika, mikroprotsessor texnikasi kurilmalari va ularni mutaxassislik yo`nalishlaridagi o`rni va qo`llanish sohalari haqida tasavvurga ega bo`lishi kerak; -Elektr zanjirlarini hisoblash va taxlil etish usullarini; -Elektronika va sxematexnika asoslari mutaxasssislik bo`yicha keng ishlatiladigan elektrotexnik va elektron avtomatlashtirilgan qurilmalarning sxemasi, tuzilishi va ishlatilishi; -Elektronika va sxematexnika asoslari zamonaviy axborat yig`ish, saqlash, qayta ishlash, undan foydalanish usullarini egallagan bo`lishi	-Yarim o`tkazgichlarning asosiy xossalari. -Yarim o`tkazgichli asboblar. -Tranzistorlar. Asosiy turlari va qo`llanilishi. -Tiristorlar. -Xotira elementlari. -Integral mikrosxemalar. -Yarim o`tkazgichli galvanomagnit asboblar. -Kvant elektronikasidan asosiy ma`lumotlar. -Foto elektrik nur o`zgartirgichlar va yorug`lik nurlantiruvchi yarim o`tkazgichli asboblar. -Optoelektron qurilmalar.	- Yarim o`tkazgichli diod - Tranzistorlar. - Tiristorlar. - Xotira elementlari. - Integral mikrosxemalar. - Yarim o`tkazgichli galvanomagnit asboblar. - Kvant elektronikasidan asosiy ma`lumotlar. - Foto elektrik nur o`zgartirgichlar va yorug`lik nurlantiruvchi yarim o`tkazgichli asboblar. - Optoelektron qurilmalar.	- Yarim o`tkazgichli diodning tavsifnomasini o`rganish. - Stabilitron va stabistorning tavsifnomasini o`rganish. - Yarim o`tkazgichli tiristorni tadqiq qilish. - Bipolyar tranzistorning xarakteristikalarini o`rganish. - O`zgaruvchan tokni o`zgarmas tokka to`g`rilash sxemalarini tadqiq etish. - Bir va uch fazali ko`prik to`g`rilash sxemalarini tadqiq qilish.
	90		**54**	**18**	**18**

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
2	**«Basics of Automatics and Microprocessors»**	Main objectives of the course: To teach students on essentials of automatics and microprocessors. By taking this course students will gain knowledge on main concepts of automatics, principles, control algorithms, types of control systems and their designs and components. At the end of the course, students will be able to understand: - Main conceptions of automatics - Control procedures and algorithms - Types of automatic control systems and significance and role of its technical facilities - Signal processors and their types - Amplifiers and alternating current amplifiers - Signal generators and harmonic signal generators - Structure of processor components - Command systems of KR580 microprocessors.Programming of simple problems	-Introduction. Course objectives and tasks -Main concepts of automatics -Control procedures and algorithms -Types of automatic control systems -Signal processors and their types -Amplifiers and alternating current amplifiers -Signal generators, harmonic signal generators -Structure of processor components -Command systems of KR580 microprocessors -Programming of simple problems		- To study inductive converters - To study logic elements, integral triggers, and encoders - To learn impulse counters - To study registers - To study resistors - To learn components and operational conditions of UMK - Writing and implementing simple programs
	51		**34**		**17**

#	Talim yo`nalish nomi, shifri, fanning nomi, umumiy soati	Fanni o`rganish natijasida bo`lajak mutaxassis quyidagilarni bilish kerak	Fan bo`yicha mavzular rejasi	Amaliyot mashgulotlarining namunaviy mavzulari	Laboratoriya mashgulotlari namunaviy dastur rejasi
2	**«Avtomatika asoslari va mikroprosessor texnikasi»**	Fanni o'qitishdan maqsad: talabalarga avtomatika asoslari va mikroprotsessor texnikasi bo'yicha boshlanhich ma'lumot berishdan iborat. Bu fanni o'rganish borasida talabalar avtomatikaning asosiy tushunchalari, boshqarish printsiplari, boshqarish algoritmlari, boshqaruv tizimlarining turlari, ularni tasvirlash, xamda ularning tarkibiy qismlari bilan tanishadilar. Bu fanni o'qigandan keyin talabalar quyidagilarni bilishlari kerak: Avtomatikaning asosiy tushunchalari; - Boshqarish tartiblari va boshqarish algoritmlarini - Avtomatik boshqaruvchi tizim turlari va texnik vositalarini axamiyati va o'rni haqida - Xabarchi qurilmalar va	Kirish. Fanning maqsadi va vazifalari. -Avtomatikaning asosiy tushunchalari; -Boshqarish tartiblari va boshqarish algoritmlarini -Avtomatik boshqaruvchi tizim turlari -Xabarchi qurilmalar va ularning turlari; -Kuchaytirgich va o'zgaruvchan tok kuchaytirgichlari; -Signal generatorlari, garmonik signallar generatori -Protsessor elementining tuzilishi; -KR580 mikroprotsessorining komanda tizimlari; -Oddiy masalalarni dasturlash		- Induktiv o'zgartgichni o'rganish - Mantiqli elementlar, integral triggerlar va deshifratorni o'rganish. - Impuls sanoqchi qurilmasini o'rganish - Registrni o'rganish - To learn resistors - UMK ni tarkibiy qismlarini va ish rejimlarini o'rganish - Oddiy dasturlarni tuzish va bajarish

		ularning turlari; -Kuchaytirgich va o’zgaruvchan tok kuchaytirgichlari; -Signal generatorlari, garmonik signallar generatori -Protsessor elementining tuzilishi; -KR580 mikroprotsessorining komanda tizimlari; -Oddiy masalalarni dasturlash			
	51		**34**		**17**

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
3	**«Theoretical basics of electro-technics»**	Main objectives of the course: To teach students linear and non-linear electrical and magnetic circuits, theory of electromagnetic poles At the end of the course, students will be able to understand: -Significance and role of theoretical essentials of electro-technics in development of national economy -Computation methods of electro-technical devices -Engineering methods for analysis of electro-technical devices -Theory of linear and magnetic circuits -Theory of non-linear and magnetic circuits -Theory of electro-magnetic fields.	- Direct current electric circuits - Sinusoidal electric current circuits - Three-phase electric circuits - Non-sinusoidal electric circuits - Processes in converters - 4-phase hardware - Filters - Electric circuits with sparse parameters - Theory of non-linear electric circuits - Theory of electromagnetic fields - Electrostatic field.	-To compute direct current circuits -Computation methods of complex circuits of direct current -To compute series and parallel resistor, inductor and capacitor circuits -To compute simple and complex electric circuit using complex method -To study electrical resonance between alternative current and voltage. -To compute inductance of circuits -To compute three-phase electric circuits -To compute non-sinusoidal alternating current circuits -Classical methods to compute transfer processes of linear electric circuits with compact parameters -Operator methods to compute transfer processes of linear electrical circuits -Theoretical determination of parameters of passive four-	- To study direct current electric circuits (experimental laboratory work on laboratory benches) - To study alternating current parameters (Virtual lab work) - To study alternating current circuits of consumers linked in series (experimental lab work on laboratory benches) - To study electrical circuits with elements connected in series (virtual lab work) - To study alternating current circuits with elements connected in parallel (experimental lab work on laboratory benches) - To study circuits with elements connected in parallel (virtual lab work)

				phase alternation circuits based on their scheme - To compute electric frequency filters - To compute electric circuits with sparse parameters - To compute non-linear direct current circuits - To compute transfer processes of non-linear electric circuits - Examples on determining equi-potential and force contours of electro-static fields - Examples applications of Maxwell's first and second equations - Examples on magnetic fields in conductor and changeable electromagnetic fields.	- To study voltage resonance (experimental lab work in laboratory benches) - To study current resonances (virtual lab work) - To study inductive electric circuits(virtual lab work) - To study three-phase electrical circuits of consumers connected in "star" form (experimental lab work in laboratory benches) - To study three-phase electrical circuits of consumers connected in "triangle" form (experimental lab work in laboratory benches) - To study non-sinusoidal dimensions (experimental lab work on laboratory benches) - Non-steady state processes of RLC circuits with constant e.m.f. (experimental lab work on laboratory benches) - Non-steady state processes of RC

					electric circuits (virtual lab work) - To study non-steady state processes in capacitors charging with active resistor and inductance charging periods (experimental lab work in laboratory benches) - To study passive four-pole circuits (virtual lab work) - To study low and high pass filters (experimental lab work in laboratory benches) - To study Ferro-resonances (experimental lab work in laboratory benches)
	216		**108**	**36**	**72**

#	Talim yo`nalish nomi, shifri, fanning nomi, umumiy soati	Fanni o`rganish natijasida bo`lajak mutaxassis quyidagilarni bilish kerak	Fan bo`yicha mavzular rejasi	Amaliyot mashgulotlarining namunaviy mavzulari	Laboratoriya mashgulotlari namunaviy dastur rejasi
3	**«Elektrotexnikaning nazariy asoslari»**	Fanni o'qitishdan maqsad: chiziqli va nochiziqli elektr hamda magnit zanjirlar, elektromagnit maydon nazariyalarini o`rganishdan iborat.  Bu fanni o'qigandan keyin talabalar quyidagilarni bilishlari kerak: - Elektrotexnikaning nazariy asoslarining xalq xo`jaligida, elektrotexnikaning rivojlanishidagi roli va ahamiyati; - Elektrotexnikaviy qurilmalarida ishlatiladigan hisoblash uslublarini; - Elektrotexnikaviy qurilmalarini tahlil qilishning muhandislik uslublari; - Chiziqli elektr hamda magnit zanjirlar nazariyalari; - Nochiziqli elektr hamda	- O`zgarmas tok elektr zanjirlari - Sinusoidal tok elektr zanjirlari. - Uch fazali elektr zanjirlar. - Nosinusoidal tok elektr zanjirlari. - O`tkazish jarayonlar. - To`rtqutbliklar. - Filtrlar. - Tarqoq parametrli elektr zanjirlar. - Nochiziqli elektr zanjirlar nazariyasi. - Elektromagnit maydon nazariyasi. - Elektrostatik maydon.	- O`zgarmas tok elektr zanjirlari xisoblash. - O`zgarmas tok murakkab elektr zanjirlari xisoblash usullari. - Rezistor, induktiv g`altak va kondensator ketma–ket hamda parallel ulangan zanjirlarni xisoblash. - Oddiy va murakkab zanjirlarni kompleks usul bilan xisoblash. - Kuchlanishlar va toklar rezonansi hodisalarini o`rganish. - Induktiv bog`lanishli zanjirlarni hisoblash. - Uch fazali zanjirlarni hisoblash. - Nosinusoidal o`zgaruvchan tokli zanjirlarni hisoblash. - Yig`iq parametrli chiziqli elektr zanjirlardagi o`tkazish jarayonlarni klassik usulda hisoblash. - Chiziqli elektr zanjirlardagi o`tkazish jarayonlarni operator usulida hisoblash. - Passiv to`rtqutbliklarning almashinish sxemasi bo`yicha	- O`zgarmas tok elektr zanjirlarini tadqiq etish (qurilmada o`tkaziladi). - O`zgaruvchan tok parametrlarini tadqiq etish (virtual laboratoriya ishi). - Iste`molchilar ketma-ket ulangan o`zgaruvchan tok zanjirini tadqiq etish (qurilmada o`tkaziladi) - Elementlari ketma ket ulangan zanjirni tadqiq etish (virtual laboratoriya ishi). - Iste`molchilar parallel ulangan o`zgaruvchan tok zanjirini tadqiq etish (qurilmada o`tkaziladi) - Elementlari parallel ulangan zanjirni tadqiq etish (virtual laboratoriya ishi) - Kuchlanishlar

		magnit zanjirlar nazariyalari; - Elektromagnit maydon nazariyasi;		ularning parametrlarini nazariy aniqlash. - Chastotali elektr filtrlarni hisoblash. - Tarqoq parametrli elektr zanjirlari xisoblash. - Nochiziqli o`zgarmas tok zanjirlarini hisoblash. - Nochiziqli elektr zanjirlardagi o`tkazish jarayonlarni hisoblash. - Elektrostatik maydondagi ekvipotentsial hamda kuch chiziqlarini aniqlashga oid misollar. - Maksvellning birinchi va ikkinchi tenglamalarini qo`llashga oid misollar. - O`tkazuvchi muxitdagi maydon va o`zgaruvchan elektromagnit maydonni aniqlashgaga oid misollar.	rezonansini tadqiq etish (qurilmada o`tkaziladi) - Toklar rezonansini tadqiq etish (virtual laboratoriya ishi) - Induktiv bog`langan zanjirlarni tadqiq etish (virtual laboratoriya ishi). - Iste`molchilari «yulduz» usulida ulangan uch fazali zanjirni tadqiq etish (qurilmada o`tkaziladi). - Iste`molchilari «uchburchak» usulida ulangan uch fazali zanjirni tadqiq etish (qurilmada o`tkaziladi). - Nosinusoidal kattaliklarni tadqiq etish (qurilmada o`tkaziladi). - Doimiy E.Yu.K. ga ega R, L, C zanjirdagi o`tkinchi jarayonlar (virtual laboratoriya ishi). - R, C zanjirdagi o`tkinchi jarayonlar (virtual laboratoriya

					ishi). - Kondensatorning aktiv qarshilik va induktivlikka zaryadsizlanishi paytidagi o`tkinchi jarayonlarni tadqiq etish (qurilmada o`tkaziladi). - Passiv to`rtqutblilikni tadqiq etish (virtual laboratoriya ishi). - Quyi va yuqori chastota elektr filtrlarini tadqiq etish (qurilmada o`tkaziladi). - Ferrorezonans xodisalarini tadqiq etish (qurilmada o`tkaziladi).
	216		**108**	**36**	**72**

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
4	**"Basics of Electro-technology"**	Main objectives of the course: To teach students how to develop theoretical aspects and how to use electro-technologic devices and systems developed while preparing the course "Basics of Electro-technology" At the end of the course, students will be able to understand: - The current state of the electrical technology and its future development trends - The significance and role of the electro-technology in national economy - Computation methods in electro-technologic devices - Engineering methods for analysis of electro-technologic devices - Physics of electro-technology - Main processes in electro-technology.	- Electro-magnetic field - Electro-thermal processes and devices - To heat using electric arc furnace - Contact welding (soldering) - Electro-thermal recycling devices of agricultural products - Recycling materials using electro-physic and electro-chemical methods - Electro-mechanical processes and devices - To heat with ions - Electro-static recycling methods of metals and optimal modes of electro-technologic devices.		- Temperature measurements in active parts of electrical oven using thermocouples and thermo resistors - To learn operational modes of an electric resistor oven - To learn operational modes of a high frequency microwave oven - To study products' surface polishing processes of products with a high voltage electron tunneling accelerometer - To study processes of making deep holes using electro-erosion technology - To study contour cutting with ultra sound wave technology.
	60		**30**	**30**	

#	Talim yo`nalish nomi, shifri, fanning nomi, umumiy soati	Fanni o`rganish natijasida bo`lajak mutaxassis quyidagilarni bilish kerak	Fan bo`yicha mavzular rejasi	Amaliyot mashgulotlarining namunaviy mavzulari	Laboratoriya mashgulotlari namunaviy dastur rejasi
4	**«Elektr texnologiya asoslari»**	Фанни ўқитишдан мақсад: «Elektr texnologiya asoslari» fani ishlab chiqarishda qo`llaniladigan elektrotexnologik qurilma va tizimlarning ishlash printsiplarining nazariy asoslarini yaratish va ekspluatatsiya qilish. Бу фанни ўргангандан сўнг талабалар қуйидагиларни билишлари керак: - Elektr texnologiyaning hozirgi davrdagi holati va kelajakda rivojlanishi; - Elektr texnologiyaning xalq xo`jaligida, texnologiyani rivojlanishidagi roli va ahamiyati; - Elektrotexnologik qurilmalarda ishlatiladigan hisoblash uslublari; - Elektrotexnologik qurilmalarini tahlil qilishning muhandislik uslublari; - Elektr texnologiyaning fizik asoslari; - Elektr texnologiyaning asosiy jarayonlari;	- Elektr magnit maydon. - Elektr termik jarayonlar va qurilmalar. - Elektr yoy yordamida qizdirish. - Kontakt payvandlash. - Qishlok xo`jaligi maxsulotlarini elektr termik qayta ishlovchi qurilmalar. - Materiallarni elektr fizik va elektr kimyoviy usullar bilan qayta ishlash. - Elektr mexanik jarayonlar va qurilmalar. - Ionlar yordamida qizdirish. - Metallarni elektrostatik qayta ishlash usullari va elektr texnologik uskunalarning optimal rejimlari.		- Elektr pech ichidagi va aktiv qismlaridagi haroratni termopara va termoqarshiliklar yordamida o`lchash . - Qarshilik elektr pechining ishga tushirish ish rejimlarini o`rganish. - Mikroto`lqinli o`ta yuqori chastotali maishiy qizdirish qurilmasining ish rejimlari. - Buyumlar sirtiga yuqori kuchlanishli elektron tezlatgichida elektron nur yordamida ishlov berish jarayoni bilan tanishish. - Elektroeroziya texnologiyasi bilan chuqur teshik ochish usuli bilan tanishish. - Ultratovush texnologiyasi yordamida konturli kesish jarayoni bilan tanishish.
	60		**30**	**30**	

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
5	**"Basics of Electric drives"**	Main objectives of the course: To teach students principles of direct current and alternating current electric drives and how to select them according to their technical requirements, problems how to analyze electro-mechanical systems and synthesize them At the end of the course, students should be able to understand: To gain knowledge on designs, operational principles and classifications, tuning principles of electric motors and maintenance electric machines.	- Introduction. Objectives of the course "Electric drives" and its tasks - Classificatin of electric-drives - Mechanics of electric drives - Electric-motor's electro-mechanical properties - Electro-mechanical and mechanical characteristics of alternating current electric motors - Asynchronous motors - Synchronous motors - Electro mechanical transfer processes - Transfer processes of direct current (DC) motors' electric drives. Braking processes of parallel coiled DC motors - Transfer processes of electric drives of asynchronous motors - Computation essentials of electric drives - Classification of operational processes of electric drives - Calculation and selection methods of electric motors	- Sample assignments for power calculation and selection of electric motor - Control schemes of electric drives and selection of their elements - Mechanical characteristics of electric motors. Mechanical characteristics of DC motors - Mechanical characteristics of alternating current motors - Tuning schemes for coordinates of electric-motors and calculating its elements	- To study mechanical characteristics of short-circuited asynchronous motors - To start asynchronous motor drive by changing its coil connection from "star" to "triangle" type - Study "generator-motor" system - To study phase asynchronous motors.

			- To study electric motors operating on nominal mode - To study and select motors electric drives working on repeatable nominal mode - Speed control of electric motors - Speed control of DC electric motors - Speed control of alternating current electric motors		
	90		**54**	**18**	**18**

#	Talim yo`nalish nomi, shifri, fanning nomi, umumiy soati	Fanni o`rganish natijasida bo`lajak mutaxassis quyidagilarni bilish kerak	Fan bo`yicha mavzular rejasi	Amaliyot mashgulotlarining namunaviy mavzulari	Laboratoriya mashgulotlari namunaviy dastur rejasi
5	**«Elektr yuritma asoslari»**	Fanni o'qitishdan maqsad: o'zgarmas va o'zgaruvchan tok elektr yuritmalarini ishlash prinsiplari, ularga qo'yiladigan talablar asosida yuritma elementlarini hisoblash va tanlash, elektromexanik tizimlarni analiz va sentezlash masalalarini o'rgatishdir. Bu fanni o`rgangandan so`ng talabalar quyidagilarni bilish kerak: Elektr mashinalarni tuzilishi, ishlash printsiplari, klassifikatsiyasi, sozlanishi bo'yicha bilimlarga ega bo'lishi va elektr mashinalariga texnikaviy xizmat ko'rsatish.	- Kirish. Elektr yuritmalar fani va uning vazifalari. - Elektr yuritmalarining klassifikatsiyasi. - Elektr yuritmalarining mexanikasi. - Elektrodvigatellarning elektromexanik xususiyatlari. - O'zgaruvchan tok elektr dvigatellarining elektromexanik va mexanik tavsiflari. - Asinxron dvigatellar. - Sinxron dvigatellar. (SD) - Elektromexanik o'tish jarayonlari. - O'zgarmas tok dvigatellik elektr yuritmalaridagi utish jarayoni. Parallel chulgamlik uzgarmas tok dvigatellarini tormozlash. - Asinxron dvigatellik (AD) elektr yuritmalaridagi utish jarayonlari. - Elektr yuritmalarini xisoblash asoslari. - Elektr yuritmalar ish jarayonlarining	-Elektr yuritmalari uchun motor quvvatlarni xisoblash va tanlash bo'yicha namunaviy masalalar -Elektr yuritmalarni boshqarish sxemalari va ularning elementlarini tanlash. -Elektr motorlarining mexanik tavsiflari. O'zgarmas tok elektr motorlarining mexanik tavsiflari. -O'zgaruvchan tok elektr motorlarining mexanik tavsiflari. -Elektr yuritmalarning koordinatlarini rostlash sxemalari va ularning elementlarini xisoblash.	- Qisqa tutashgan rotorlik asinxron motorlarining mexanik tavsiflarini tadqiq etish. - Asinxron motorli yuritmaning stator chulg'amlarini «yulduz» ulanishdan «uchburchak»ga o'tkazib ishga tushirish - Generator – motor tizimini tadqiq etish. - Faza rotorlik asinxron motorlarni tadqiq etish.

			klassifikatsiyasi. - Elektr dvigatelini xisoblash va tanlash. - Nominal ish rejimida ishlovchi elektr dvigatellarni tekshirish. - Qaytalanuvchi nominal ish rejimida ishlovchi elektr yuritmalar dvigatellarni tanlash va tekshirish. - Elektr yuritmalari tezligini boshkarish. - O’zgarmas tok elektr dvigatellarining tezligini boshkarish. - O’zagruvchan tok elektr yuritmalari tezliklarini boshkarish.		
	90		**54**	**18**	**18**

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
6	**"Electric and electronic devices"**	The purpose of this course is to teach students about electronics and electrical devices in technical controller systems. The syllabus of the course contains information commutation devices, relays, starters, controllers of electrical and non-electrical parameters, measurement devices, electrical regulators, amplifiers and signal generators. From this course students will gain knowledge on: -Roles of electrical and electronic devices in control, types, properties, failure reasons, and ways of solving their failures. Students will gain skills in: - tuning and operating electrical and electronic devices used in automatic control systems, and if required, capable of operating new devices.	-Intoduction - Classification of electrical devices -Switch, relay and protector - Automatic devices -Electromagnets. Electromagnetic force. -Relay devices. Electromagnetic relays and theirs types - Electromagnetic clutches and theirs types -Contactor and magnetic starters -Electrical contractors, and their dimensions and materials - Transistor amplifiers, and their operational methods and types -Direct current amplifiers - Alternating current amplifiers - Task amplifiers and their usage -Standard signal generators and their types -Harmonic signal generators -Periodic right angle signal generators - Contactless switches and their types - Semi-conductor relays and their types	- Emitter follower and its properties. Power amplifier cascade. - Differential – balance cascade and its properties. Task amplifiers and their properties. - Standard signal generators. Harmonic signal generators. Relay harmonic signal generators. - Periodic right angle signal generators and building methods. Multivibrator device, and its structure and properties. - Contactless semi-conductor relays. Photo-, thermo-, time-relays. - Contactless semi-conductor relays. Transistor switch, and its structure and operational procedure. - Thruster switches and their control methods. Structure of thruster and its operational procedure.	-To study electromagnetic relay. -To study contactors and magnetic starters -To study direct and alternating current amplifiers. -To study harmonic signal generators. -To study contactless relays. -To study semiconductor relays.
	84		**42**	**42**	

#	Таълим йўналиш номи, шифри, фаннинг номи умумий соати	Фанини ўрганиш натижасида бўлажак мутахассис қуйидагиларни билиши керак	Фан бўйича мавзулар режаси	Амалиёт машғулотларининг намунавий мавзулари	Лаборатория машғулотлари намунавий дастур режаси
6	**“ Электр ва Электрон аппаратлар”**	Фаннинг асосий максади: талабаларга бошқариш техникасида қўлланиладиган электр ва электрон аппаратлари тўғрисида маълумот беришдан иборат. Йўналиш фанлари мазмунини анализ килиш натижасида бериладиган маълумот коммутацияловчи, чекловчи, ишга туширувчи, бошқарувчи, электр ва ноэлектр қатталикларни назорат килувчи, улчов аппаратлар ва электр ростлагичлари, ҳамда кучайтиргичлар, сигнал генераторлари туғрисидаги ахборотни ўз ичига олади.	-Кириш. -Электр аппаратларини класификацияси -Узгич, қайта улагич ва сақлагичлар -Автоматлар -Электромагнитлар. Электромагнитнинг тортиш кучи - Реле қурилмалари. Электромагнитли реле ва уларнинг турлари - Электромагнитли муфталар ва уларнинг турлари - Контактор ва магнитли ишга туширгичлар - Электр контактлари, уларнинг материаллари ва ўлчамларини аниқлаш - Транзисторли кучайтиргичлар, ишлаш усули ва турлари. - Ўзгарувчан ток кучайтиргичлари - Ўзгармас ток	- Эмиттер такрорлагичи ва унинг хусусияти. Қувватни оширувчи маскад. - Дифференциал-баланс маскад ва унинг хусусияти. Вазифавий кучайтиргичлар ва уларнинг хусусияти. - Стандарт сигнал генераторлари. Гармоник сигнал генератори. РС-гармоник сигнал генератори . - Тўғрибурчакли даврий сигнал генераторлари, яратиш усули. Мултивибратор қурилмаси, тузилиши ва хусусияти. - Контаксиз ярим ўтказгичли релелар. Фото -, термо -, вақт релелари. - Ярим ўтказгичли контакциз улагичлар: транзисторлик қалит, тузилиши ва ишлаш тартиби. - Тиристорлик улагичлар ва уларни бошқариш усуллари . - Тиристорлик улагичнинг тузилиши ва ишлаш тартиби .	- Электромагнитли релени тадқиқ этиш. - Контактор ва магнитли ишга туширгичларни тадқиқ этиш. - Ўзгарувчан ва ўзгармас ток кучайтиргичларини тадқиқ этиш. - Гармоник сигнал генераторларини тадқиқ этиш. - Контакциз улагичларни тадқиқ этиш. - Ярим ўтказгичли релени тадқиқ этиш.

		Бу фанни ўргангандан сўнг талабалар қуйидагиларни билишлари керак: ▪ электр в электрон аппараларнинг бошқаришдаги ўрни, уларнинг турлари, хусусиятлари, созлаш йўллари, бузилиш сабаблари ва уларни бартараф қилиш йўллари. Натижада талабаларда қуйидаги кўникмалар шаклланиши керак: ▪ маълум бир мавжуд автоматик бошқарувчи тизим таркибида ишлатилган электр ва электрон аппаратларни ишлаш тартибини созлаш йўлларини билиш, керак бўлса мазкур тизим таркибига янги аппаратни ишлатиш қобилиятига эга бўлиши керак.	кучайтиргичлари. - Вазифавий кучайтиргичлар ва улардан фойдаланиш - Стандарт сигнал генераторлари ва уларнинг турлари. - Гармоник сигнал генераторлари - Даврий тўғрибурчакли сигналгенераторлари - Контакциз улагичлар ва уларнинг турлари - Ярим ўтказгичли реле ва уларнинг турлари		
	84		**42**	**42**	

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
7	**“Microprocessors and electronic control of automobiles”**	The purpose of this course is to teach students about automatic digital devices, microprocessors and electronic control system of automobiles. Besides, logical basics of digital devices, logical devices and their creating methods, properties of microprosessors, structures and their role in control systems, and their programming methods programming simple problems and electronic control systems of automobiles. As a result students will gain knowledge on: - analog and digital data processing methods and their application methods	- Introduction. Automatic digital devices - Combinatorial Logic devices - Encoder, decoder and encoders - Multiplexers and demultiplexers - Integral triggers. Counters and their applications - Registers. Storage devices. - Microprocessors - Processors and ways of designing processors - Processors. Two ways of designing processors. Processors built with logic circuits - Processors (Microprocessor КР580ИК80А) built with programming logic - Main component of КР580ИК80А digital processor - Structure of the microprocessor built on components of 580 microprocessor - Input and Output interfaces of microprocessors - Communication types between microprocessors and external devices - Programming languages. Features of assembler language. Linear, transferable and loop programming languages.		- To study logical devices (4 hours) - To studyRS, D and JK triggers (4 hours) - To studycounters(4 hours) - To study registers (4 соат). - To study multiplexors (4 hours) - Address types and command formats (4 hours) - To develop simple programs and execute them (4 hours) - To study components and operational modes ofmicroprocessors(8 hours) - To devise condtional transitions andto encode data (4 hours) - 10.To use subroutines in writing programs (6 hours) - 11.To input and output data, connect

		- Logic basics of digital devices, logic elements and their types, and types of logic devices. Methods to create logical devices operating in combination and series. Integral schematic types of triggers, encoders, decoders, multiplexers and demultiplexers. Storage devices and their types. Counters and their types, registers and their types, analog-to-binary converters, digital-to-analog converters, digital automatic devices, their (description) types. Methods to create digital automatic devices.	- Subroutines in programming and their use - Whole crystal micro-computers - Register-register architecture - Using microprocessor sin mechatronic systems - Engine's electronic control module. Electronic control system of a throttle; - Crank shaft position sensor - Fuel level gauge sensor. Ignition inductor - Control module of a headlight system. Diagnostic sensor module. Cruise control module and antilock system. ABSsystem.		display and keyboard with micro-processor (6 hours) - 12. To study automobile's injection system and its sensors (6 hours)
	84		**56**		**28**

#	Таълим йўналиш номи, шифри, фаннинг номи умумий соати	Фанини ўрганиш натижасида бўлажак мутахассис қуйидагиларни билиши керак	Фан бўйича мавзулар режаси	Амалиёт машғулотларининг намунавий мавзулари	Лаборатория машғулотлари намунавий дастур режаси
7	**«Микропроцессор техникаси ва автомобилни электрон бошқариш»**	Фаннинг асосий максади: талабаларга автоматиканинг рақамли қурилмалари, микропроцессор техникаси,хамда автомобилларнинг электрон бошқарувчи тизимлари тўғрисида маълумот беришдан иборат. Булар қаторига рақамли техниканинг мантиқавий асослари, мантиқли қурилмалар ва уларнинг яратиш усуллари, микропроцессор техникасининг хусусиятлари ва уларни бошқаришдаги аҳамияти, микропроцессорли тизимларнинг тузилиши ва ишлаши,дастур турлари, оддий масалаларни дастурлаш,автомобилларнинг электрон бошқарувчи тизимлари ҳақидаги маълумотлар киради.	-Кириш. Автоматиканинг рақамли қурилмалари. -Комбинацион мантиқли қурилмалар -Шифратор, дешифратор ва код ўзгартгичлари -Мултиплексор ва демултиплексорлар -Интеграл триггерлар. Саноқчи қурилмалар ва улардан фойдаланиш -Регистрлар. Хотира қурилмалари -Микропроцессор қурилмалари. -Процессор қурилмаси ва уни яратиш. -Процессор қурилмаси -Процессор қурилмаларини қуришда икки ёндошиш. Схема мантиғи асосида қурилган процессор қурилмалари -Дастурлаш мантиғи асосида қурилган процессор қурилмалари -КР580ИК80А микропроцессори -КР580ИК80А рақамли		1. Мантиқли қурилмаларни ўрганиш (4 соат). 2. RS, D и JK-триггерларни ўрганиш (4 соат). 3. Саноқчи қурилмаларни ўрганиш (4 соат). 4. Регистрни ўрганиш (4 соат). 5. Мултиплексорни ўрганиш (4 соат). 6. Адреслаш турлари ва команда форматлари (4 соат). 7. Оддий дастурларни тузиш ва бажариш (4 соат). 8. УМК нинг таркибини ва иш режимларини ўрганиш (6 соат). 9. Шартли ўтишларни ташкил қилиш ва маълумотларни ниқоблаш (4соат). 10.Дастур тузишда

		Бу фанни ўргангандан сўнг талабалар қуйидагиларни билишлари керак: ахборотга аналоговий ва рақамли ишлов беришни хусусиятлари ва улардан фойдаланиш йўллари. Рақамли техниканинг мантиқавий асослари, мантиқли элементлари ва уларнинг турлари, мантиқли қурилмаларнинг турлари. Комбинацион ва кетма-кет ишловчи мантиқли қурилмаларни яратиш усуллари. Интеграл схема кўринишидаги триггерлар, шифратор, дешифратор, кодларни ўзгартирувчи қурилмалар, мултиплексор ва демултиплексор. Хотира қурилмалари ва уларнинг турлари; саноқчи қурилмалар ва унинг турлари; регистрлар ва уларнинг турлари, АЦП ва ЦАП қурилмалари, рақамли автоматлар, уларни тасвирлаш турлари. Рақамли автоматларни яратиш усуллари.	марказий процессор элементи. -КР 580 микропроцессори комплекти (МПК) асосида қурилган МП – тизимларнинг структураси. -МП қурилмаларининг киритиш ва чиқариш интерфейслари (ИВВ). -Микропроцессор ва ташқи қурилмалар орасидаги алоқа турлари -Дастурлаш турлари. Ассемблер тилининг хусусияти. Чизиқли, ўтиш мавжуд былган, циклик хисоблаш мавжуд былган дастурлар -Дастур ости ва ундан фойдаланиш -Яхлиткристалли микро-ЭХМлар -Регистр-регистрли архитектура -Мехотроник тизимларда микропроцессорларнинг қўлланилиши -Двигателни электрон бошқариш модули. Дроссел заслонкасини электрон назорат қилиш тизими. Тирсакли вал холати датчиги(СКР). Ёқилғи сатхини ўлчаш		дастур остилардан фойдаланиш (6соат). 11.Маълумотларни киритиш ва чиқаришни, дисплей ва клавиатурани микроЭҲМ га боғлашни ўрганиш (6соат). 12. Автомобилнинг пуркаш тизими хабарчи қурилмаларини ўрганиш (6 соат).

			датчиги. Ўт олдириш ғалтаги -Ёритиш тизимини бошқариш модули -Сезувчи диагностик модули -Круиз назорат модули, антиблокировка тизими. ABS тизими		
	84		**56**		**28**

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
8	**«Use of automotive electrical devices»**	The purpose of this course is to teach students about basics of using automobile's electrical devices, according to the general requirements for specialists in the specialization area. The main objectives of the subject are to study reliability automobile's electrical devices and their service maintenance, and diagnostics, to locate and fix their failures By the end of this discipline students will be able to understand: Electrical power supply systems of automobiles, engine start, ignition system, control and level measurement devices, headlight and warning devices, electronic control system of automobiles and its operation, repair and diagnostics methods.	- Role of diagnostics and elecetical devices in efficient use of automobiles - Diagnostics and maintenance of electrical devices and systems of automobiles. - Basics of using accumulator batteries. - Basics of using electrical starters. - Basics of using alternating current generators and voltage regulators. - Basics of using electrical ignition systems - Basics of using information systems and sensors - Basics of using light, illumination and sound signal devices - Essentials of using electrical transmissions and accessories		- Checking and diagnostics of automotive accumulator batteries - Checking and diagnostics of automotive generators - Checking and diagnostics of voltage regulators - Checking and diagnostics of automotive starters - Checking and diagnostics of automotive ignition devices - Checking automotive control-measurement devices - Checking commutation systems with E-204

			- Essentials of using electronic systems and devices.		tool. - Checking automotive headlight system devices - Searching and fixing main failures in an electronic control system of automobiles - Checking and operational maintenance on electrical circuits of electronic control system.
	110		**55**		**55**

#	Таълим йўналиш номи, шифри, фаннинг номи умумий соати	Фанини ўрганиш натижасида бўлажак мутахассис қуйидагиларни билиши керак	Фан бўйича мавзулар режаси	Амалиёт машғулотларининг намунавий мавзулари	Лаборатория машғулотлари намунавий дастур режаси
8	**«Автомобилларнинг Электр жиҳозларини ишлатиш асослари»**	Мазкур фанни асосий мақсади: талабаларга автомобилларнинг электр жихозларини ишлатиш асослари буйича таълим йуналиши профилига мос билим, кўникма ва малака шакллантиришдир. Фанни ўрганиш вазифалари куйидагилардан иборат: автомобилларнинг электр жихозлари (АЭЖ) ишончлилиги, АЭЖлар эксплуатацияси, уларга сервис хизмат кўрсатиш ва диагностикаси асосларини, АЭЖларининг носозликларини қидириш усуллари ва воситаларини, носозликларини бартараф этиш асосларини ва улардан фойдалана билишдир Бу фанни ўргангандан сўнг талабалар қуйидагиларни билишлари керак: автомобилларнинг электр таъминоти, двигателни	- Автомобиллардан самарали фойдаланишда электр жихозларини ишлатиш ва диагностикасининг тутган ўрни. - АЭЭЖ буюмлари ва тизимларини техник эксплуатация ва диагностика қилишни ташкил этиш. - Аккумулятор батареяларини ишлатиш асослари. - Электр стартёрларини ишлатиш асослари. - Ўзгарувчан ток генераторлари ва кучланиш ростлагичларини ишлатиш асослари. - Электр ўт олдириш тизимини ишлатиш асослари. - Ахборот тизими ва датчикларииии ишлатиш асослари. - Ёритиш техникаси,		- Автомобиль аккумулятор батареясини диагностика қилиш ва текшириш. - Автомобиль генераторини диагностика қилиш ва текшириш. - Кучланиш ростлагичларини диагностика қилиш ва текшириш. - Автомобиль стартерларини диагностика қилиш ва текшириш. - Автомобилнинг ўт олдириш аппаратларини диагностика қилиш ва текшириш. - Автомобиль назорат-ўлчов асбобларини текшириш - Э-204 асбоби ёрдамида

		юрғизиб юбориш, ўт олдириш, назорат-ўлчов асбоблари, ёритиш ва дарак бериш хамда автомобиль ва унинг агрегатларини электрон бошқариш тизимларини ишлатиш, таъмирлаш ва диагностика қилиш асослари, уларда ишлатиладиган стенд, қурилма ва асбоблар, уларда учрайдиган асосий носозликларни бартараф этиш технологияси хамда улар тўғрисида билим, кўникма ва малакаларга эга бўлиш каби талаблар қўйилади.	ёруғлик ва товушли сигнал бериш асбобларини ишлатиш асослари. - Электр узатмалар ва ёрдамчи электр жихозларини ишлатиш асослари. - Электрон тизим ва қурилмаларини ишлатиш асослари.		коммутация буюмларини текшириш. - Автомобиль ёрнгиш тизими асбобларини текшириш. - Автомобиль ва унинг агрегатларини электрон бошкариш тизимини асосий эксплуатациои носозликларини излаш ва бартараф этиш. - Электрон бошқариш тизимининг электр занжирини текшириш ва техник хизмат кўрсатиш.
	110		**55**		**55**

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
9	**«Automatic control systems»**	The purpose of this course is to teach students main concepts of automation, control techniques and algorithms, automatic control systems, automation methods and technical means, static characteristics of automatic control systems, static and astatic automatic control systems, dynamics properties of automatic control systems, transfer and frequency characteristics, to study steady state conditions of automatic control systems with Gurvits and Mikhailov methods, and analyses and conclusions of results from differential outputs of automatic control systems. From this course students will learn: - main concepts of automation - control techniques and algorithms - automatic control systems, their role and significance - steady state and transfer	- Introduction. General concepts and expressions of automation - Control methods and algorithms - Automatic control system types - Methods and technical implementation tools of automation - Transfer and steady state conditions of automatic controll systems - Static characteristics of automatic control system. - Static and astatic automatic control systems - Dynamic characteristics of automatic control system - Transfer characteristics of automatic control system - Frequency characteristics of automatic control system - Logarithmic frequency characteristics of automatic control system - Steady state condition of automatic control systems - To study steady state condition of automatic	- To study structure and characteristics of automatic regulation system - To study structure and characteristics of programmable control systems - To study structure and characteristics of a relay regulator of a pressure receiver - To study static characteristics of automatic system - Transfer characteristics of automatic control system - Frequency characteristics of automatic control system - Steady state condition of automatic control system	- To study inductor converter - To study transfer characteristics of a system with computer - To study a system property correction with computer - To study a system frequency characteristics with computer - To study steady state condition of a system with a Mikhailov godographby using computer modeling

		positions of automatic control systems - static and astatic automatic control systems - dynamic properties of automatic control systems and their transfer positions - logarithmic frequency characteristics of automatic control system - frequency logarithmic characteristics of auromatic control systems - Mikhailov and Gurvits principles of steady-state conditions of automatic control systems - Design and correction of automatic control systems	control systems with Gurvits methods - To study steady state condition of automatic control systems with Mikhailov methods - Differential equations of automatic control system - Correction of automatic control systemproperties - Development of correction devices		
	90		**54**	**18**	**18**

#	Talim yo`nalish nomi, shifri, fanning nomi, umumiy soati	Fanni o`rganish natijasida bo`lajak mutaxassis quyidagilarni bilish kerak	Fan bo`yicha mavzular rejasi	Amaliyot mashgulotlarining namunaviy mavzulari	Laboratoriya mashgulotlari namunaviy dastur rejasi
9	**«Avtomatik boshqarish тizimlari»**	Fanni o'qitishdan maqsad: talabalarga avtomatikaning asosiy tushunchalarini o'rgatish, boshqarish usullari va boshqarish algoritmlari, avtomatik boshqaruvchi tizim turlari; avtomatikaning usullari va texnik vositalari, avtomatik boshqaruvchi tizimning statik tavsifi, statik va astatik avtomatik boshqaruvchi tizimlar, avtomatik boshqaruvchi tizimning dinamik xususiyati, o'tish tavsiflari, chastotali tavsifilarini o'rgatish; avtomatik boshqaruvchi tizim barqarorligini Gurvis, Mixaylov ususlarida o'rganishga yo'naltirish, avtomatik boshqaruvchi tizimning differentsial olingan natijalarga asosli xulosalar chiqarish Bu fanni o'qigandan keyin talabalar quyidagilarni bilishlari kerak: - Avtomatikaning asosiy	- Kirish. Avtomatika asosiy tushunchalari va ifodalari. - Boshqarish usullari va boshqarish algoritmlari. - Avtomatik boshqaruvchi tizim turlari. - Avtomatikaning usullari va texnik vositalari. - Avtomatik boshqaruvchi tizimning muvozanat va o'tish holatlari. - Avtomatik boshqaruvchi tizimning statik tavsifi. - Statik va astatik avtomatik boshqaruvchi tizimlar. - Avtomatik boshqaruvchi tizimning dinamik xususiyatlari. - Avtomatik boshqaruvchi tizimning o'tish tavsiflari. - Avtomatik boshqaruvchi tizimning chastotali tavsifi. - Avtomatik boshqaruvchi tizimning logarifmik chastotali tavsifi. - Avtomatik boshqaruvchi tizimning barqarorligi - Avtomatik boshqaruvchi tizim barqarorligini Gurvits	- Avtomatik rostlovchi tizim tuzilishi va xususiyatlari bilan tanishish. - Dasturli boshqariladigan tizim tuzilishi va xususiyati bilan tanishish. - Resiver bosimi rele rostlagichini tuzilishi va xususiyatini o'rganish. - Avtomatik tizim statik xarakteristikasi. o'rganish. - Avtomatik boshqaruvchi tizimning o'tish xarakteristikasi. - Avtomatik boshqaruvchi tizimning chastotali xarakteristikasi. - Avtomatik boshqaruvchi tizim barqarorligi.	- Induktiv o'zgartichni o'rganish. - Tizim o'tish xarakteristikasini EHM da o'rganish. - Tizim xususiyatini korrektsiyalashni EHM da o'rganish. - Tizim chastotali tavsifini EHM da o'rganish. - Tizim barqarorligini Mixaylov godografi asosida EHM da modellash orqali o'rganish.

		tushunchalari va ifodalarini; - Boshqarish usullari va boshqarish algoritmlari ***bilishi***; - Avtomatik boshqaruvchi tizim turlari va texnik vositalarini axamiyati va o‘rni haqida tasavvurga ega bo‘lishi; - Avtomatik boshqaruvchi tizimning muvozanat va o’tish holatlari; - Statik va astatik avtomatik boshqaruvchi tizimning bilishi va foydalana olishi; - Avtomatik boshqaruvchi tizimning dinamik xususiyatlari va o’tish tavsiflari; - Avtomatik boshqaruvchi tizimning logarifmik chastotali tavsifi; - Avtomatik boshqaruvchi tizim barqarorligini Mixaylov va Gurvits usullari; - Avtomatik boshqaruvchi tizimning korrektsiyalash va ularni yaratish bo‘yicha	usulida o’rganish. - Avtomatik boshqaruvchi tizim barqarorligini Mixaylov usulida o’rganish. - Avtomatik boshqaruvchi tizimning namunaviy zvenolari. - Avtomatik boshqaruvchi tizimning differentsial tenglamasi. - Avtomatik boshqaruvchi tizim xususiyatini korrektsiyalash. - Korrektsiyalovchi qurilmalar va ularni yaratish.		
	90		**54**	**18**	**18**

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
10	**Electric components of automobiles and tractors**	The purpose of this course is to teach students about reliability and efficient use of electrical components of automobiles and general concepts on their role and significance in providing ecological safety of vehicles, electrical power supply, light, start and ignition, and warning systems of modern vehicles, and components, operational principles and maintenance of diagnostic devices, development trends of electrical components and their testing and analyses of obtained data from tests. By studying in this course a student will gain knowledge in: - Current status and development trends of electrical components of automobiles and tractors - Requirments for electrical equipments of automobiles and tractors - role and significance of	- Introduction. - Electrical power supply systems of automobiles and tractors - Start upsystem of internal combustion engines - Ignition system - Information-diagnostic system of automobiles - A light and warning system with lights - Electronic control system of automobiles - Assitance and commutation devices and their accessories		- Vehicle generators (to study structure of alternating current generators and diagnostics of their technical condition. Identification and analysis of electrical characteristics of current generators. To study operational procedures of voltage regulators). - Accumulator batteries (to study structure of accumulator battery, to determine level of discharge. To obtain and analyze characteristics of voltage - amper of accumulator batteries) - Vehicle starters (to studyvehicle starters' structures and to perform diagnostics of vehicle starters) - Vehicle ignition system (to study

		electrical components in efficient operation and reliability of automobiles and tractors - general structure and separate fuctional systems of electrical components of automobiles and tractors - structure, function, and operational priciple of specific electrical componentsof automobiles and tractors - acquisition of system characteristics of main units of electrical components ofautomobile sand tractors - identification and fixing of failures of electrical components of automobiles and tractors - diagnostics of electrical components of of automobiles and tractors			operational principles of vehicle ignition systems their components. To test, analyze and obtain characteristics of contact, contact-transistor and electronic ignition systems) - Information-diagnostic system of vehicles (to studystructure and operational principleof information-diagnostic systems) - Light and warning system (to study main headlights, anti-fog lights, their operation and structure) - Electronic control systems of vehicles (to study control systems of an engine fuel injection system and K-Jetronic, KE-Jetronic, L-Jetronic, Mono-Jetronic, Motroniccontrollers' components)
	90		**68**		**34**

#	Talim yo`nalish nomi, shifri, fanning nomi, umumiy soati	Fanni o`rganish natijasida bo`lajak mutaxassis quyidagilarni bilish kerak	Fan bo`yicha mavzular rejasi	Amaliyot mashgulotlarining namunaviy mavzulari	Laboratoriya mashgulotlari namunaviy dastur rejasi
10	**Avtomobil va traktorlarning elekt jihozlari**	Fanni o'qitishdan maqsad: talabalarga elektr jihozlarining avtomobillarning ishonchli va samarali ishlatishda, ularning ekologik xavfsizligini ta'minlashdagi tutgan o'rni va ahamiyati haqida tushuncha berish; hozirgi zamon avtomobillarining elektr ta'minot, ishga tushirish, o't oldirish, yoritish va darak berish tizimlari, nazorat-o'lchov asboblarini tuzilishi, ishlashi va ularga xizmat ko'rsatish asoslarini o'rgatish; elektr jihozlarning rivojlanish istiqbollari bilan talabalarni tanishtirish, ularda elektr jihozlarini sinash va olingan natijalarga ko'ra asosli xulosalar chiqarish bo'yicha ko'nikmalar hosil qilish Bu fanni o'qigandan keyin talabalar quyidagilarni bilishlari kerak: - Avtomobil va	- Kirish - Avtomobil va traktorlarning elektr ta'minot tizimi. - Ichki yonuv dvigatellarini ishga tushirish tizimi. - O't oldirish tizimi. - Avtomobillarning axborot-diagnostik tizimi. - Yoritish va yorug'li darakchilari tizimi. - Avtomobilning elektron boshqarish tizimlari. - Yordamchi va kommutatsiya jihozlari, o'tkazgichlar		- Avtomobil generatorlari (O'zgaruvchan tok generatorlarining tuzilishini o'rganish va ularning texnik holatini aniqlash. - O'zgaruvchan tok generatorlarining elektr tavsifnomalarini olish va ularni tahlil qilish. - Zamonaviy kuchlanish rostlagichlarining ishlash prinsipini o'rganish) - Akkumulatorlar batareyasi (Akkumulatorlar batareyasining tuzili-shini o'rganish, ularning razryadlanganlik darajasini aniqlash. - AKB ning volt - amper tavsifnomasini olish va tahlil qilish) - Avtomobil startyorlari

		traktorlarning elektr jihozlarining xozirgi holati va rivojlanish istiqbollari; - Avtomobil va traktorlarning elektr jihozlariga qo‘yiladigan talablar; - Avtomobil va traktorlarning ishonchli va samarali ishlatishda elektr jihozlarining axamiyati va o‘rni haqida tasavvurga ega bo‘lishi - Avtomobil va traktorlarning elektr jihozlarining umumiy sxemasi va uning alohida funktsinal tizimlari; - Avtomobil va traktor elektr jihozlarining aloxida asbob va agregatlarni vazifasi, tuzilishi, ishlash prinsipi va tavsifnomalarini bilishi va foydalana olishi - Avtomobil va traktorlarning elektr jihozlariga taalluqli asosiy tizim va agregatlarini tavsifnomalarini olish va tahlil qilish; - Avtomobil va traktorlarning elektr jihozlarini nosozliklarini aniqlash va bartaraf qilish;			(Zamonaviy avtomobil startyorlarining tuzilishini o‘rganish, ularning texnik holatini aniqlash) - O‘t oldirish tizimi (Zamonaviy o‘t oldirish tizimlarining ishlash prinsipi, ularga taalluqli jihozlarni tuzilishini o‘rganish. Kontaktli, kontakt-tranzistorli va elektron o‘t oldirish tizimlari sinash, ularning tavsifnomalarini olish va tahlil qilish) - Avtomobillarning axborot-diagnostika tizimi (Avtomobillarning axborot-diagnostika tizimiga taalluqli asboblarning tuzilishini va ishlashini o‘rganish) - Yoritish va yorug‘lik darakchilari tizimi (Bosh yoritish faralari, tumanga qarshi faralar, yorug‘lik darakchilarining

		- Avtomobil va traktorlarning elektr jihozlarini texnik holatini aniqlash va tahlil qilish bo‘yicha			tuzilishi va ishlashini o‘rganish) - Avtomobillarning elektron boshqarish tizimlari (Zamonaviy dvigatellardagi yonilg‘i purkash tizimlarini boshqarish usullari- K-Jetronic, KE-Jetronic, L-Jetronic, Mono-Jetronic, Motronic va ularga taalluqli asboblarni o‘rganish)
	90		**68**		**34**

Curriculum analysis for the Bachelor's program "5310600 - Ground vehicle and exploitation (Road construction machine)" at TARI

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
11	**Hydraulics, hydro pneumatic actuators**	Discipline, "hydraulics, hydro pneumatic actuators" is one of the general engineering disciplines for training of specialists majoring in ground vehicle engineering to solve a main problem of transportation as defined in decrees of the government of the republic. The purpose of the course is to introduce the main theoretical and practical conditions of equilibrium and fluid flows in hydraulic systems of vehicles and service organizations, providing reliability, durability and traffic safety.	- Introduction. Physical properties of liquids, Hydrostatics. Pressure. - Concept of pressure. Manometer/pressure gauge. Vacuum-meter/ Vacuum gauge. Hydrostatic paradox. - Liquid pressure on the plane and cylindrical walls. - Archimedes principle, Floating bodies. - Hydrodynamics. Main elements of flows. - Bernoulli equation for an ideal fluid and the whole flow of a real fluid. - Hydraulic resistance. Two flow modes. Pressure loss due to friction. - Pressure loss on local resistance. - Liquid leakage through holes and nozzles. - Liquid flows in pipes. - Hydraulic calculation of long plain pipes.		- To measure hydrostatic pressure. - Building pressure and piezo-metric lines. - Study a consumption diaphragm. - Study fluid flows in pipes. - Study pressure losses in equalized flows. - Study pressure losses local resistance. - Liquid flow through a small circular hole in a thin wall. - Fluid flow through the nozzle.

			- Hydraulic machines. - Height of centrifugal pump suction head. - Piston pumps. Indicator diagram. - Sequential and parallel operating pumps. - Rotary pumps, rotary gear pumps. - Hydraulic drives. - Hydrodynamic transmissions.		
	54		**36**		**18**

#	Таълим йўналиш номи, шифри, фаннинг номи умумий соати	Фанини ўрганиш натижасида бўлажак мутахассис қуйидагиларни билиши керак	Фан бўйича мавзулар режаси	Амалиёт машғулотларининг намунавий мавзулари	Лаборатория машғулотлари намунавий дастур режаси
11	**5310600-Ер усти транспорт тизимлари ва уларнинг эксплутацияси (ЙҚМ)**	Дисциплина "Гидравлика, гидропневмо приводы" являетса общеинженерной дисциплиной в подготовке специалистов по надземный транспортный средства для решения основной задачи транспорта, определенной в решениях правительства республики. Целью подготовки преподавания дисциплины является изложение основных теоретических и практических положений равновесия и движения жидкостей в гидросистемах автотранспортных средств и подсобных предприятий, обеспечивающих надежность, долговечность, безопасность движения.	1. Введение. Физические свойства жидкостей, Гидростатика. Давление. 2. Понятие о напоре. Манометр. Вакумметр. Гидростатический парадокс. 3. Давления жидкости на плоские и цилиндрические стенки. 4. Закон Архимеда, Плавание тел. 5. Гидродинамика. Основные элементы потока. 6. Уравнение Бернулли для идеальной жидкости и целого потока реальной жидкости. 7. Гидравлические сопротивления. Два дежима движения. Потери напора на трение. 8. Потери напора на местных сопротивлениях. 9.Истечение жидкости из отверстий и насадков. 10. Движение жидкости по трубопроводу. 11. Гидравлический расчет		1. Измернеие гидростатического давления. 2. Построения напорной и пьезометрической линий. 3. Исследование расхода диофрагмы. 4. Исследование режимов движения жидкости в трубах. 5. Исследование потерь напор при равномерном установившемся движении. 6. Исследование потерь напор на местных сапротивлениях. 7. Истечение жидкости через малое круглое отверстие в тонкой стенке. 8.Истечение жидкостей через насодки.

			простого длинного трубопровода. 12.Гидравлические машины. 13. Высота всасывания центробежных насосов. 14. Поршневые насосы. Индикаторная диаграмма. 15. Последовательная и параллельная работа насосов. 16. Роторные насосы, Шестеренные насосы. 17.Гидравлические приводы. 18.Гидродинамические передачи.		
	54		**36**		**18**

Curriculum analysis for the Master's program "5A310607– Dynamics and Durability of Machines, Devices and Tools" at TARI

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
12	**"Vehicle Dynamics and Reliability"**	The main course objective is to enable graduate students to gain skills how to choose parameters of machines and mechanisms, and analyze them, and understand equations of motion of vehicles under given conditions, study complex equations of motion of vehicles by using computer modeling tools. The course objectives in teaching students are: - To compute technical characteristics of vehicles and be able to implement them in designing processes; - To study loading conditions of vehicle components and select computation methods; - To select methods and tools to assess convergence of obtained results;	- Development trends of machine design. - External and internal forces and torques applied on vehicles. Equations of linear motion of a vehicle - Specifics of power dynamics of a vehicle with hydraulic transmission - Forces and torques applied on a vehicle in curvilinear motion. Calculation of parameters of curvilinear motion of a vehicle - Forces and torques applied on a wheel during the braking process. Stability during the braking process. - Motion of a vehicle during the braking process in a cyclic mode equipped with the ABS. - Vibration types occurred in vehicles. The frequency-amplitude characteristics and transfer functions of	- Numerical calculations of parameters of motion of a vehicle with hydraulic transmission. - Numerical calculations of parameters of curvilinear motion of a vehicle. - Numerical calculations of parameters of the braking process of a vehicle. - Numerical calculations of vertical motions of a vehicle. -Technique of elastoplastic calculations of spatial model of a bar.	- Defining statistical characteristics micro profile of terrain surface using measurement results to solve problems of vehicle dynamics -Defining characteristics of the friction linings of brake mechanisms. Determining friction coefficient. Determining strength of a lining and friction force with a metal surface of pads - Determining the strength of the framework elements of cabin on impact force.

			vibrating systems. - Loading modes and operating conditions - Calculation methods on strength of individual units and parts of a vehicle - Influence of different factors on the strength of parts - Methods of elasto-plastic calculations of a spatial (3D) model of the rod - Selection of rational profiles for frame structures of vehicles. - Increasing strength and rigidity of frame structures.		
	60		**30**	**20**	**10**

#	Таълим йўналиш номи, шифри, фаннинг номи умумий соати	Фанини ўрганиш натижасида бўлажак мутахассис қуйидагиларни билиши керак	Фан бўйича мавзулар режаси	Амалиёт машғулотларининг намунавий мавзулари	Лаборатория машғулотлари намунавий дастур режаси
12	**«Машиналар динамикаси ва мустаҳкамлиги»**	Фанни ўқитишдан мақсад, магистрларнинг машина ва механизмларнинг параметрларини танлаш ва тахлил қила олиш кўникмасини олиш, берилган эксплуатацион хусусиятларни жорий этишни таъминлайдиган машиналарнинг харакатланиш қонуниятларини ўрганиш, ЭХМ дастурларини қўллаган ҳолда машиналарни мураккаб ҳаракат жараёнини хисоблаш бўйича билимларини шакллантириш. Фанни ўрганиш вазифаси талабаларга қуйидагиларни ўргатиш: -машинанинг эксплуатацион хусусиятлари кўрсаткичларни ҳисоб асосида аниқлаш ва уларни	1. Тенденция развития конструкции машин. 2. Внешние и внутренние силы и моменты действующие на колесную машину. Уравнения прямолинейного движения колесной машины 3. Особенности расчета тягово-скоростных свойств машин с гидрообъемной трансмиссией 4. Силы и моменты, действующие на машину при криволинейном движении. Расчет параметров криволинейного движения машины 5. Силы и моменты, действующие на колесо при торможении. Устойчивость при торможении 6. Движение машин при торможении в	1. Численный расчет параметров движения машины с гидрообъемной трансмиссией. 2. Численный расчет параметров криволинейного движения машины. 3. Численный расчет параметров процесса торможения машины. 4. Численный расчет вертикальных колебаний машины. 5. Методика упругопластического расчета пространственной модели стержня.	1.Определение статистических характеристик микропрофиля опорной поверхности по результатам измерений для решения задач динамики автомобиля 2.Определение характеристик фрикционных накладок тормозных механизмов. Определение коэффициента трения. Определение прочности накладки и прочности сцепления с металлической основой колодки 3.Определение прочности элементов каркаса кабины при ударных нагрузках.

		машина конструкциясига киритиш усуллари; - машина деталларининг кучланиш режимларини аниқлаш ва ҳисоб усулларини танлаш; -олинган натижаларни мослигини текшириш учун усул ва воситаларни танлаш.	циклическом режиме с применением АБС 7. Виды колебаний машин. Амплитудно-частотные характеристики и передаточные функции колебательных систем 8. Нагрузочные режимы и условия эксплуатации 9. Методика расчета на прочность отдельных узлов и деталей автомобиля 10. Влияние различный факторов на прочность деталей 11.Методика упругопластического расчета пространственной модели стержня 12. Выбор рациональных профилей каркасных конструкций машин. 13.Повышение прочности и жёсткости каркасных конструкций.		
	60		**30**	**20**	**10**

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
13	**"Dynamics of vehicle transmissions"**	Course objectives and tasks: The course objectives are to enable graduate students to gain knowledge and skills to determine vehicle parameters computationally according to set requirements on the design phase, to introduce to graduate students updated understandings on theory of loadings on units and parts of a vehicle in various operating conditions, computation methods of vehicle durability and longevity, and main test methods of vehicles on set loading modes on parts, mechanisms and units of vehicles.	- Introduction. Concepts how to improve designs of vehicle transmissions. - Mechanical transmissions -Hydromechanical transmissions of buses lorries and cars - Influence of design features, operating conditions and steering methods of a vehicle on loaded modes - Theory of vibrations of loading in transmissions of two-axle vehicles - To determine external influences on transmission performance during vibration of a two-axle vehicle - Comparative assessment of fatigue durability of vehicle transmission parts at random loading processes.	- Analysis of transmission designs of GM Uzbekistan and SamAuto vehicles - To set up computation conditions for transmission parts of a car, city bus and four wheel drive lorry; - To calculate stresses in parts of vehicle transmissions; - To carry out assessment calculations of shafts and gears of gearbox; - To determine critical frequency of driveshaft rotation; -The analysis of unit power-output and fuel-efficiency indicators of cars and lorries with hydro-mechanical transmissions. - To develop an operational algorithm of automatic control system of torque distribution between driving axles of a vehicle.	- Defining transferred stiffness of transmission; -To determine maximal peak loading in vehicle transmission by an experimental-calculation method; -To compile the simplified calculation scheme of a car four-by-two drive wheels based on experimental data; -To determine characteristics of a torsional vibration damper; -To determine a turning angle and torsional stress of a shaft of drive-wheel drive of a vehicle; -To determine statistical characteristics of a micro-profile of terrain surface using measurement results to

					solve problems of vehicle dynamics; -To determine mathematical expectation and micro-profile dispersion by using computer; -To determine a correlation function and function of spectral density of loading in various parts of a vehicle by computer modeling. -Experimental-computational modeling of vehicle motion on uneven terrains; - To develop methods and programs of testing to define fatigue characteristics of vehicle parts;
	120		**60**	**40**	**20**

#	Таълим йўналиш номи, шифри, фаннинг номи умумий соати	Фанини ўрганиш натижасида бўлажак мутахассис қуйидагиларни билиши керак	Фан бўйича мавзулар режаси	Амалиёт машғулотларининг намунавий мавзулари	Лаборатория машғулотлари намунавий дастур режаси
13	**«Динамика трансмиссий самоходных машин»**	**Цель и задачи преподавания дисциплины:** Данная дисциплина ставит целью формирование у магистрантов знаний, умений и навыков по расчетному определению параметров автомобилей, обеспечивающих заданные требования на стадии проектных решений, ознакомление магистрантов с современными представлениями о теории формирования нагрузок в узлах и деталях автомобиля в различных условиях эксплуатации, изучение методов расчета автомобиля на прочность и долговечность, а также с основными методами испытаний автомобилей по установлению нагрузочных режимов узлов, механизмов и агрегатов автомобиля.	1. Введение. Концепции совершенствования конструкций трансмиссий автомобилей. 2. Механические трансмиссии 3. Гидромеханические трансмиссии автобусов грузовых и легковых автомобилей 4. Влияние особенностей конструкции, условий эксплуатации и способов управления автомобилем на нагрузочные режимы 5. Теория колебаний нагрузки в трансмиссии двухосных автомобилей 6. Формирование внешних воздействий на трансмиссию при колебаниях двухосного автомобиля 7. Сравнительная оценка усталостной прочности деталей трансмиссии автомобиля при случайном процессе нагружения.	1.Анализ конструкций трансмиссий автомобилей GM Uzbekistan и SamAvto 2.Установление расчетных режимов деталей трансмиссии легкового автомобиля, городского автобуса и грузового автомобиля с колесной формулой 4х4; 3.Расчетное определение напряжений в деталях трансмиссии автомобилей; 4.Проведение проверочных расчетов валов и шестерен коробок передач; 5.Определение критической частоты вращения карданного вала; 6.Анализ удельных тягово-скоростных и топливно-экономических показателей легковых и грузовых автомобилей с гидромеханической трансмиссией. 7.Составление алгоритма работы системы	1. Определение приведенной жесткости трансмиссии; 2. Определение максимальной пиковой нагрузки в трансмиссии автомобиля расчетно-экспериментальным методом; 3. Составление упрощенной расчетной схемы автомобиля с колесной формулой 4х2 на основе экспериментальных данных; 4. Определение характеристик гасителя крутильных колебаний; 5. Определение угла закрутки и напряжений кручения вала привода ведущего колеса

				автоматического управления распределением крутящего момента между ведущими мостами автомобиля.	автомобиля; 6. Определение статистических характеристик микропрофиля опорной поверхности по результатам измерений для решения задач динамики автомобиля; 6.1. Определение математического ожидания и дисперсии микропрофиля с помощью ЭВМ; 6.2. Определение корреляционной функции и функции спектральной плотности нагрузок в различных деталях автомобиля моделированием на ЭВМ. 7. Расчетно-экспериментальное моделирование движения автомобиля по неровной дороге; 8. Составление методики и программы испытаний по определению усталостных характеристик деталей автомобиля;
	120		**60**	**40**	**20**

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
14	**"Vibration, vibro-isolation and design"**	-The purpose of this course is to enable graduate students to gain skills in how to choose necessary methods for validating of dynamic and vibration isolation/ vibration isolation parameters of vehicles and devices, and their efficient uses. - Task of the course is to teach graduate students - in essentials of the theory of vibration, study methods of vibration processes of linear mechanical systems with finite number of degrees of freedom, methods of compiling dynamic models of vibration systems with various degrees of freedom; - in choosing methods of compiling the differential equations of vibrations with a glance into account and without dissipation; - in determining natural frequencies and natural mode shapes, building frequency response function	- Basic concepts and definitions. -Vibration systems with the finite number degrees of freedom. - The fundamental equations of the system with finite number of degrees of freedom. - Systems with a single degree of freedom with linear restoring force and friction. -Linear systems with Multiple-Degrees-of-Freedom. - The forced vibrations, linear systems with single degree of freedom without friction. - Systems with single degree of freedom with restoring force and friction. - Classification of vibration isolation systems and basic requirements to vibration isolation systems. - Calculation of vibration isolation systems with single degree of freedom. - Linear vibration isolation systems with Multiple-Degrees-of-Freedom.	- Numerical computation of parameters of free vibrations of vibrating systems. - Deriving differential equations of free vibration. -Compiling differential equations of vibrations of sprung mass during movement of a wheel on uneven roads. - Deriving equations of forced vibrations. - Calculating vibration isolation systems with various control reactions. - Calculating vibration isolation effects of various devices.	- To define vibration characteristics of vibration isolation devices using measurement results to solve problems of vibration isolation of mechanisms and vehicles, and also, human - operator. - To define general and active levels of vibration velocity and acceleration on vibration isolation objects. - To define effect of the vibration isolation / in active frequency band.

		characteristics of vibration isolation systems; - in choosing reasonable parameters of a dynamic vibration damper; - in calculating dynamic parameters of vibration isolation systems;	-Methods and means to define vibration characteristics of mechanisms and vehicles experimentally.		
	74		**28**	**26**	**20**

#	Таълим йўналиш номи, шифри, фаннинг номи умумий соати	Фанини ўрганиш натижасида бўлажак мутахассис қуйидагиларни билиши керак	Фан бўйича мавзулар режаси	Амалиёт машғулотларининг намунавий мавзулари	Лаборатория машғулотлари намунавий дастур режаси
14	**«Вибрация, виброзащита и проектирование»**	Целью преподавания дисциплины является формирование у магистрантов навыков вибора необходимого метода для обоснования динамических и виброзащитных параметров машин, приборов и аппаратуры и эффективного его использования. Задачей настоящего курса является обучить магистрантов; -основам теории колебаний, методам изучения колебательных процессов линейных механических систем с конечным числом степеней свободы, методам составления динамических моделей колебательных систем с различными степенями свободы; -вибору метода составления дифференциальных	1. Введение. Основные понятия и определения. Introduction. 2. Колебания систем с конечным числом степеней свободы. 3. Основные уравнения систем с конечным числом степеней свободы. 4. Системы с одной степенью свободы при наличии линейной восстанавливающей силы и трения. 5. Линейные системы с несколькими степенями свободы. 6. Вынужденные колебания, линейные системы с одной степенью свободы при отсутствии трения. 7. Колебательные системы с одной степенью свободы при	1. Численный расчет параметров свободных колебаний колебательных систем. 2. Вывод дифференциальных уравнений свободных колебаний. 3. Составить дифференциальное уравнение колебаний подрессоренного груза при движении колеса по неровному участку пути. 4. Вывод уравнений вынужденных колебаний. 5. Расчет виброзащитных систем с различными закономерностями воздействия. 6. Расчет эффекта виброзащиты различных устройств.	1.Определение вибрационных характеристик виброзащитных устройств по результатам измерений для решения задач виброзащиты механизмов и машин, а также человека - оператора. 2. Определение общих и активных уровней виброскорости и виброускорений на объектах виброзащиты. 3. Определение эффекта виброзащиты в активных полосах частот.

		уравнений колебаний с учетом и без учета диссипации; -определению собственных частот и форм собственных колебаний, построению амплитудно-частотных характеристик виброзащитных систем; -вибор рациональных параметров динамического гасителя колебаний; параметров виброзащитных систем;	наличии восстанавливающей силы и трения. 8. Классификация виброзащитных систем и основные требования к виброзащитным системам. 9. Расчет виброзащитных систем с одной степенью свободы. 10. Линейный виброзащитные системы с несколькими степенями свободы. 11. Методы и средства экспериментального определения вибрационных характеристик механизмов и машин.		
	74		**28**	**26**	**20**

Curriculum analysis for the Master's program "5A310604 – Vehicles and vehicle maintenance" at TARI

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
15	**"Mechatronic systems of vehicles"**	- Objectives of this course are to teach graduate students to gain skills in design and production of qualitatively new modules, systems, cars and complexes of cars, and on their basis - moving intelligent cars and systems, acquaintance of undergraduates with modern ideas of the theory of creation and operation of cars and systems with computer traffic control, studying of methods of calculation of electronics and microprocessor equipment, informatics and computer traffic control of cars and units, and also with the main test methods of cars on establishment of load modes of knots, mechanisms and car units.	-Basic concepts and definitions -Principles of mechatronic system design -Mechatronic modules of motion -Intelligent mechatronic modules of motion -Application areas of mechatronic systems -Electric, hydraulic and pneumatic actuators of mechatronic systems -Control systems of Mechatronic devices -Sensors of mechatronic systems. Classification and characteristics of sensors. -Structural modeling of mechatronic systems. -Application areas of robots and robotic systems. Classification of industrial robots and their specifications. -Application of mechatronic systems in automobile, water and air transportation systems		- Modeling of linear systems of automatic control. -Standard dynamic links of systems. Automatic control. -Analysis of accuracy of systems of automatic control. - Research of stability of systems of automatic control - Research of frequency characteristics of links of automatic control systems. -Correction of static properties of automatic control systems (ACS). -Correction of dynamic properties of the ACS. - Study of stability and quality of linear ACS with delay. - Communication of frequency characteristics of the

			-Nanotechnology and mechatronics.		open systems with temporary characteristics of a closed system of automatic control. -Study of control of subsystems in Matlab package (setting up for symmetric optimum).
	80		**40**		**40**

#	Таълим йўналиш номи, шифри, фаннинг номи умумий соати	Фанини ўрганиш натижасида бўлажак мутахассис қуйидагиларни билиши керак	Фан бўйича мавзулар режаси	Амалиёт машғулотларининг намунавий мавзулари	Лаборатория машғулотлари намунавий дастур режаси
15	**«Мехатронные системы машин»**	Данная дисциплина ставит целью формирование у магистрантов знаний, умений и навыков по проектированию и производству качественно новых модулей, систем, машин и комплексов машин, а на их основе - движущихся интеллектуальных машин и систем, ознакомление магистрантов с современными представлениями о теории создания и эксплуатации машин и систем с компьютерным управлением движением, изучение методов расчета электроники и микропроцессорной техники, информатики и компьютерного управления движением машин и агрегатов, а также с основными методами испытаний машин по	1. Основные понятия и определения. 2. Принципы построения мехатронных систем. Мехатронные модули движения. Интеллектуальные мехатронные модули движения. Сферы применения мехатронных систем. 3. Электрический, гидравлический и пневматический приводы мехатронных систем. 4. Системы управления мехатронными устройствами. 5. Датчики мехатронных систем. Классификация и характеристики. 6. Структурное моделирование мехатронных систем. 7. Области применения роботов и робототехнических систем. Классификация		1. Моделирование линейных систем автоматического управления. 2. Типовые динамические звенья систем. Автоматического управления. 3. Анализ точности систем автоматического управления. 4. Исследование устойчивости систем автоматического управления. 5. Исследование частотных характеристик звеньев систем автоматического управления. 6. Коррекция статических свойств САУ. 7. Коррекция

		установлению нагрузочных режимов узлов, механизмов и агрегатов машины.	промышленных роботов и их технические характеристики. 8. Применение мехатронных систем на автомобильном, водном и воздушном транспорте. 9. Нанотехнология и мехатроника.		динамических свойств САУ. 8. Исследование устойчивости и качества линейной САУ с запаздыванием. 9. Связь частотных характеристик разомкнутой системы с временными характеристиками замкнутой системы автоматического управления. 10. Исследование систем подчинённого регулирования в пакете Matlab (настройка на симметричный оптимум).
	80		**40**		**40**

#	TARI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
16	**"Mathematical modeling of processes and numerical solutions"**	The main goal of the course is to teach graduate students how to select mathematic modeling tools and their uses in defining dynamics and strength parameters of machines and devices. Objectives of the course in teaching students are the followings: - To select scheme of object or process and to build mathematical models - Mathematical processing of experimental data; - To introduce essentials of ordinary, partial differential and integral equations; - To build equations of motion of vibrating bars; - To build equations of motion using summed and distributed mass parameters; - To solve algebraic equations using numerical methods; - To solve integral-	- The basic definitions of mathematic modeling. Classification of Mathematic modeling. - To choose a design model. - To choose computation model of an object or process - Optimization modeling. - To build optimization problems and to solve them - Application of algorithmic modeling in processing experimental data - Sorting out experimental data - Analyze experimental data using interpolation method with polynomials - Approximation of experimental data - Numerical methods to solve systems of linear and nonlinear algebraic equations - Ordinary Differential Equations - Solution methods ordinary dirrerential equations	-To choose computation model of an object or process -To build optimization problems and to solve them -To solve systems of linear equations numerically -To solve systems of non-linear equations and quadratures (integrals) numerically -Approximate solution search of first order dirrerential equations - Approximate solution search of higher order dirrerential equations -Solving partial differential equations numerically and analytically -Computation of transverse and torsional vibrations of straight bars -Calculation of mode shapes and frequencies of straight bars - To derive equations of motion using summed mass and distributed mass methods -To solve differential equations by using finite difference method -Solving differential equations	- Sorting experimental data - Application of interpolation method with polynomials to analyze experimental data - Approximation of experimental data

		differential equations using numerical methods; - To apply finite difference, finite element and variation methods; - To apply trigonometric series in solving differential equations.	- Approximation solution methods to solve systems of first order dirrerential equations - Approximation solution methods to solve systems of high order differential equations - Partial differential equations - Solution methods of partial differential equations - Analytical and numerical solution methods of partial differential equations - Mathematical model of longitudinal and torsional vibrations of a straight bar - Calculation of longitudinal and torsional vibrations of a straight bar - Mathematical model of transverse vibrations of a straight bar - Calculation of natural frequencies and mode shapes of a straight bar - Deriving equations of motion using summed mass and distributed mass methods - Solving equations of motion using summed and distributed mass methods - Finite Difference Method	by using Finite Element Method	

			- Solving differential equations by using finite difference method - Boundary element method - Solving differential equations by using boundary element method - Finite Element Method - Solving differential equations by using finite element method - Software packages using Finite Element Method - Solving mechanical engineering problems by using software packages (I-Deas, SolidWorks and etc.)		
	80		**60**	**50**	**10**

#	Таълим йўналиш номи, шифри, фаннинг номи умумий соати	Фанини ўрганиш натижасида бўлажак мутахассис қуйидагиларни билиши керак	Фан бўйича мавзулар режаси	Амалиёт машғулотларининг намунавий мавзулари	Лаборатория машғулотлари намунавий дастур режаси
16	**«Жараёнларни математик моделлаштириш ва санокли ечиш»**	Фанни ўқитишдан мақсад, магистрларга машина, асбоб-ускуналарнинг динамик ва мустаҳкамлик параметрларини асослаш учун зарур бўлган математик аппаратни танлаш ва ундан самарали фойдаланиш кўникмасини шакллантириш Фанни ўрганиш вазифаси талабаларга қуйидагиларни ўргатиш: - объект ёки жараённинг схемасини танлаш ва математик моделини тузиш; - тажриба натижаларини математик қайта ишлаш; - оддий, хусусий хосилали дифференциал тенгламалар ва интеграл тенгламалар ҳақида маълумот бериш; -стерженларнинг тебраниш тенгламаларини қуриш; - ҳаракат тенгламаларини тўпланган масса ва тақсимланган параметрлар	1. Математик моделлаштиришнинг асосий тушунчалари. Математик моделларнинг классификацияси 2. Ҳисоб схемасини танлаш 3. Объект ёки жараённинг ҳисоб схемасини танлаш 4. Оптимизацион моделлаштириш 5. Оптималлаштириш масалаларини қуриш ва ечиш. 6. Тажриба натижаларини қайта ишлашда алгоритмик моделлаштиришни қўллаш 7. Тажриба натижаларини шакллантириш 8. Тажриба натижаларини интерполяцион кўпҳад ёрдамида ёритиш 9. Тажриба натижаларини аппроксимациялаш 10. Чизиқли ва чизиқли бўлмаган алгебраик тенгламалар тизимини санокли ечиш усуллари	1. Объект ёки жараённинг ҳисоб схемасини танлаш 2. Оптималлаштириш масалаларини қуриш ва ечиш 3. Чизиқли тенгламалар тизимини санокли ечиш 4. Чизиқли бўлмаган тенгламалар тизимини ва интегралларни санокли ечиш 5. Биринчи тартибли оддий дифференциал тенгламалар тизимини такрибий ечиш. 6. Юқори тартибли оддий дифференциал тенгламалар тизимини такрибий ечиш. 7. Хусусий хосилали дифференциал тенгламаларни аналитик усулда ва санокли ечиш 8. Тўғри стержен бўйлама ва буралма тебранишларини ҳисоблаш 9. Тўғри стержен тебранишининг хос шакли ва частотасини ҳисоблаш 10. Ҳаракат тенгламаларини тўпланган масса ва тақсимланган	1.Тажриба натижаларини шакллантириш; 2.Тажриба натижаларини интерполяцион кўпҳад ёрдамида ёритиш; 3.Тажриба натижаларини аппроксимациялаш.

		усуллари орқали қуриш; - алгебраик тенгламалар тизимини саноқли усулларни қўллаб ечиш; -интегро-дифференциал тенгламаларни саноқли усуллар билан ечиш; - чекли фарқланган, чекли элементлар ва вариацион - фарқли усулларни қўллаш; -дифференциаль тенгламаларни ечишда тригонометрик қаторлардан фойдаланиш.	11. Оддий дифференциал тенгламалар 12. Оддий дифференциал тенгламаларни ечиш усуллари 12. Биринчи тартибли оддий дифференциал тенгламалар тизимини тақрибий ечиш 13. Юқори тартибли оддий дифференциал тенгламалар тизимини тақрибий ечиш 14. Хусусий хосилали дифференциал тенгламалар 15. Хусусий хосилали дифференциал тенгламаларни ечиш усуллари 16. Хусусий хосилали дифференциал тенгламаларни аналитик усулда ва саноқли ечиш 17. Тўғри стержен бўйлама ва буралма тебранишларининг математик модели 18. Тўғри стержен бўйлама ва буралма тебранишларини ҳисоблаш 19. Тўғри стержен кўндаланг тебранишининг математик модели	параметрлар усуллари орқали ечиш 11. Дифференциал тенгламаларни чекли айирмалар усули ёрдамида ечиш 12. Дифференциал тенгламаларни чекли элементлар усули ёрдамида ечиш	

			20. Тўғри стержен тебранишининг хос шакли ва частотасини ҳисоблаш 21. Ҳаракат тенгламаларини тўпланган масса ва тақсимланган параметрлар усуллари орқали қуриш 22. Ҳаракат тенгламаларини тўпланган масса ва тақсимланган параметрлар усуллари орқали ечиш 23. Чекли айирмалар усули 24. Дифференциал тенгламаларни чекли айирмалар усули ёрдамида ечиш 25. Чегаравий элементлар усули 26. Дифференциал тенгламаларни чегаравий элементлар усули ёрдамида ечиш 27. Чекли элементлар усули 28. Дифференциал тенгламаларни чекли элементлар усули ёрдамида ечиш 29. Чекли элементлар усулига асосланган замонавий дастурлар комплекси 30. Замонавий дастурлар комплекси (I-Deas, SolidWorks ва бошқалар) ёрдамида механика масаларини ечиш		
	80		**60**	**50**	**10**

CURRICULUM ANALYSIS AT JOHANNES KEPLER UNIVERSITY OF LINZ

Curriculum analysis for the Master's programme Mechatronics at Johannes Kepler University of Linz

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
1	**[MEMPBKVAPRE] KV Adaptive and predictive Control**	Extension of the known control methods to a class of time-varying systems (e.g., change of material properties, fatigue). Introduction to predictive control.	- Repetition of the relevant system theoretical fundamentals • Identification: Advanced methods for modeling using measurement data - Recursive Identification - Model reference adaptive system - Gain Scheduling - Predictive Control		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
2	**[MEMPBKVHMAL] KV Advanced Machine Design]**	Mechanisms and gear trains and kinematics: - Functions of gears - Transmission behaviour of gears - Gear synthesis and its description - Gears with special kinematics on the basis of selected examples Advanced methods for stress analysis:	- Fatigue phenomena of metals - Stress analysis methods on the basis of modern strength and damage theories - Fracture mechanical analysis - Thermal calculation of machine elements - Heat conduction and heat transmission (theory and mathematical methods) - Methods to improve heat transfer		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
3	**[MEMPBKVUETE] KV Communications Engineering**	- Introduction into the basics of communications engineering students should get: - basic understanding of communication systems - basic knowledge about representation of signals and systems in communications - general knowledge about analog and digital modulation - Basic in Communications Engineering •Analog vs. Digital Transmission •Information Sources and Their Signals •Transmission Channels - Signals and Systems in Communications Engineering •Lowpass- und Bandpass-Systems •Equivalent Lowpass-Signals and -Systems •Discrete-Time Signals and Systems •Stochastic Signals in Communications	- Analog Modulation •Basics of Modulation and Demodulation •Amplitude Modulation •Heterodyne Receiver •Frequency Modulation - Digital Modulation •Modeling a Digital Communication System •Intersymbol interference and 1. Nyquist Criterion •Matched Filter •Power Spectral Density and Eye-Diagram •PCM		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
4	**[MEMPBKVCOPE] KV Computer Aided Product Development**	Teaching of the fundamentals of Computer-Aided Product Development and modelling	- Phases of the product development process (actual process models for mechanical engineering and mechatronics, characteristics of the different phases) - Overview over types of models and modeling (specification models,) - Methods and tools for design-oriented calculation and simulation (analytical and numerical methods for the applications below) - Application of models, methods and tools in the Computer-Aided Product Development Process (Statics, Machine Dynamics, Thermal problems, Parametric design, first estimates for Preliminary Design)		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
5	**[MEMPBKVRTNS] KV Control Theory of Nonlinear Systems**	Introduction into the theory and methods for nonlinear continuous dynamical systems and its application. Basic knowledge of analysis methods for the class of nonlinear, time invariant, continuous systems. Recognition and usage of general abstract structures of dynamical systems by means of functional analytical methods.	Introductory examples to nonlinear dynamic systems, existence and uniqueness theorem for the initial value problem of ordinary differential equations, inverse function thoerem, second order systems, theorem of Poincare-Bendixson, Flat systems, Liapunov theory, invariance principle, the determination of the zone of attraction, theorem of Zubov.		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
6	**[MEMPBKVDISV] KV Discrete Time Signal Processing**	This course aims to teach how to analyse and design digital signal processing systems as well as the implementation in signal processors, to provide knowledge about the sources of error and the theory concerning signals and systems.	This course covers the following topics: - Linear systems and Laplace transform (repetition) - Analogue filters (design methods, realisation) - Sampling theorem (mathematical description) - Digital Filters (FIR-filter, IIR-filter) - Properties and design rules - Filter structures (direct structures, cascade structures, lattice structures) - Effects of word length when using fixed comma arithmetics - Discrete Fourier transform (DFT, FFT, implementation) - Spectral analysis - Chirp-z transform - Cepstrum analysis - Multi rate systems		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
7	**[MEMPBKVEANT] KV Electrical Drives**	Knowledge of field oriented control of AC drives	The combined lecture is an advanced course about field oriented control (also known as vector control) of AC machines. After the basic introduction (space vector theory, transformations, torque generation) the vector control of the permanent magnet excited synchronous machine, the (external excited) salient pole machine, the reluctance machine and the induction machine is discussed. The formal descriptions are given and the advantages and drawbacks of the control schemes are outlined in detail.		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
8	**[MEMPBKVENEF] KV Electrical Networks and Electromagnetic Fields**	Getting acquainted with the electromagnetic field equations and the foundations of network theory as well as with basic applications in antennas, waveguides and in one- and two-port theory.	Systematic network analysis, two-port theory, fundamental network properties (symmetry, reciprocity), integral theorems, vector analysis, fields in material media (magnetization and polarization, Clausius-Mosotti model), reciprocity theorem, solution of Maxwell's equations (wave equation, retarded potentials), reflection and transmission of EM-waves, TE und TM-waves, fundamentals of EM waveguides and antennas, relation network-description - field description.		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
9	**[MEMPBKVHKMK] KV Higher Kinetics - Multibody Systems**	Get a profound understanding of the dynamics of rigid and elastic multibody systems	Modeling of rigid and elastic multibody systems, analytical and synthetic methods in dynamics (and method comparison), subsystem description, solution algorithms		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
10	**[MEMPBKVNFTM] KV Nonlinear Field Theories of Mechanics**	Fundamental concepts of non-linear continuum mechanics in a non-cartesian description, as realized in modern FE-formulations, such as ABAQUS	• Vector- and tensoralgebra • Deformation measures • Measures of strength		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
11	**[MEMWAKVSEHY] KV Servohydraulics**		Servo hydraulics comprises all systems using hydraulic actuators in a feedback control loop. The course introduces the technology of servo hydraulic components, especially servo valves and servo cylinders. The focus lies on mathematical modeling, numerical simulation, and the necessary comprehension for the application of the presented technology. About a third of the course is dedicated to case studies showing the use of selected methods taken from control theory.		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
12	**[MEMPBKVTHFD] KV Thermofluiddynamics**	Conveying advanced theories and methods of fluid mechanics and thermodynamics, discussion of practice-related examples	- basic equations (Navier-Stokes equations) - exact solutions of Navier-Stokes equations - boundary-layer theory - heat transfer - convectional flows		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
13	**[MEMWBUERMS1] UE Control of nonlinear mechatronic systems 1**	The objective is to train and apply the methods presented in the lecture for the analysis and design of nonlinear complex dynamical multi-input multi-output systems to specific control problems and examples.	Mathematical basics for the theory of nonlinear dynamical systems, application examples of nonlinear systems, methods for the analysis of nonlinear systems, singular perturbation theory (slow and fast manifold, multi-scale models), sensitivity analysis, Lyapunov stabilty for autonomous and nonautonomous systems, Barbalat's Lemma, Lyapunov based control design (PD control, computed torque, integrator backstepping, generalized backstepping, adaptive backstepping), passivity, positive realness, dissipativity, Kalman-Yakubovich-Popov Lemma, actuator/sensor collocation, Port-Hamiltonian systems, passivity-based control		
	1,25 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
14	**[MEMWBUERMS2] UE Control of nonlinear mechatronic systems 2**	Application of the geometric control theory of continuous, nonlinear dynamical systems, basic knowledge of analysis and design methods for the class of nonlinear systems. Deepened understanding and recognition of general abstract structures of dynamical systems by means of differential geometry.	Introduction into the differential geometry, abstract manifolds, tangent and cotangent bundle, Lie derivative, tensor calculus, Grassmannalgebra, exterior derivative, Input/Output linearization, reachability and observability		
	1,25 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
15	**[MEMWBUEMFBM] UE Modern Frequency Domain Methods in Control**	Introduction into the theory of frequency domain methods for continuous dynamical systems, basic knowledge of analysis and design methods for linear, time invariant systems. Deepened understanding of general, abstract structures of dynamical systems by means of algebra and Fourier analysis.	Ring of stable transfer functions, Euclidean ring, parametrization of all controllers that lead to an internally stable control loop in the SISO case, Fourier analysis, H2 controller design for SISO systems, H-(infinity) controller design for SISO systems, Smith- and Smith-McMillan form, parametrization of all controllers that lead to an internally stable control loop in the MIMO case		
	1,25 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
16	**[MEMWBVORMS1] VL Control of nonlinear mechatronic systems 1**	The objective is to gain a fundamental understanding and the ability to work with the corresponding methods for the analysis and design of nonlinear complex dynamical multi-input multi-output systems based on solid mathematical concepts.	Mathematical basics for the theory of nonlinear dynamical systems, application examples of nonlinear systems, methods for the analysis of nonlinear systems, singular perturbation theory (slow and fast manifold, multi-scale models), sensitivity analysis, Lyapunov stabilty for autonomous and nonautonomous systems, Barbalat's Lemma, Lyapunov based control design (PD control, computed torque, integrator backstepping, generalized backstepping, adaptive backstepping), passivity, positive realness, dissipativity, Kalman-Yakubovich-Popov Lemma, actuator/sensor collocation, Port-Hamiltonian systems, passivity-based control		
	3 ECTS				

#	Master's program, course title, total number of hours	Learning outcomes	Main content of the course	Topics of Practical works	Topics of Lab works
17	**[MEMWBVOPAU1] VL Control System Technology 1**	Knowledge of advanced analysis and design methods for linear and time invariant systems in the frequency domain.	fourier analysis, Introduction to stochastics, non-parametric process identification, norms for signals and systems, feedback design based on Schneider, uncertain models and robustness, Smith-predictor, algebraic- and analytical restrictions, phase-formula, uncertain polynomials		
	3 ECTS				

Curriculum analysis for the Master's programme Mechatronics at KU Leuven

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
1.	**H04Q7A Identification and Advanced Control of Mechatronic Systems**	The student is able to perform frequency domain identification experiments and to evaluate the obtained results based on scientific grounds, and this using available Matlab-code. The student is able to design advanced feedback and feedforward controllers based on performance and robustness specifications in time and/or frequency domain, estimates of system model uncertainty, and this using available Matlab-code. The student is able to apply these methods in a group of 2 or 3 persons, on a mechatronic single-input motion systems. The student is able to interprete, evaluate and present the obtained results, motivate the choices made during the design and formulate design changes, all based on scientific grounds.	1) Introduction to system identification, differences between time and frequency domain identification, properties of parameter estimation methods, relation between different approaches 2) Frequency identification of linear time invariant systems: -design of excitation signals for frequency response function measurement, -estimation of frequency response functions (FRFs) -deterministic and stochastic frequency domain identification methods (parametric models) -model validation techniques -estimation of the influence of nonlinear distortions on accuracy of FRF measurements 3) Advanced control design -differences between collocated and non-collocated control -basics of feedforward control design -robust loopshaping feedback control design, mixed-sensitivity H-infinity control design -introduction to iterative learning control design	The students do a system identification and control design research project in groups of 2 or 3, on a simplified mechatronic single-input motion system. This includes: derivation of a dynamic system model, system identification (experiment design, estimation of frequency response function, estimation of parametric system model and model uncertainty, model validation), perform control design according to project specification, critically validate and compare controllers in simulation and experimentally. Prepare scientific presentation of this research project.	
	6.0 ECTS		**5.28 ects.**	**0.72 ects.**	

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
2.	**H9X39A Mechatronics drive systems**	Insight in the construction, functioning and use of drives on the basis of electrical actuators, completed with power electronics, sensors and controls. This course is intended for system-integrated engineers who have to use these drives in global systems.	**Electrical Drives: Lecture (B-KUL-H04A5a)** Basic Concepts of control, measuring, mechanical couplings and power electronics for drives • Classification of electric actuators and characterization of loads • DC drives: stationary and transient behavior, and construction and setting of control loops (torque, speed, position control) • AC drives: o Induction Machines -Scalar control: subsynchronous cascade, U / f control, field weakening -Derivation and implementation field oriented (FOC) and direct torque control (DTC) o Synchronous machine types - Synchronous machines with emphasis on permanent magnet machines with sinusoidal control - Brushless DC Machine - Switched-reluctance	See the contents of the lectures.	See the contents of the lectures.

			machine - Stepper motors • Servo drives • Linear actuators • Selection of applications, in accordance with each of the machine types: electric transportation (hybrid and electric vehicles, trains), electrical energy (variable-speed wind turbines), robotics • Implementation aspects o Sensors (e.g. speed) o Digital DSP system implementation o Parasitic problems including thermal management, electromagnetic compatibility, power quality, noise and vibration o Energetic aspects: efficiencies The exercises and laboratory sessions focus on demonstrating the different drives based on real systems. Students optimize at least one type of drive starting calculations, from simulation to verification in lab. **Mechatronic Drive Systems: Lecture (B-KUL-H04N8a).** Actuators are a basic component in each		

			mechatronic system (machine). In this course, the different types of actuators (apart from pneumatic and hydraulic ones) that are used in mechatronic systems: electric, piezoelectric, magnetostrictive, memory alloys, electroreological, electromagnetic, thermal, electrostatic... actuators. A lot of attention will go to the integrating aspect, such as the interaction of the drive system with the mechanical structure.		
	6.0 ECTS		**- 2.41 ects.** **- 2.7 ects.**	**0.3 ects.**	**0.59 ects.**

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
3.	**H04U1C Optimization of Mechatronic Systems**	The student is able to independently define and solve practical optimization problems for mechatronic systems (e.g. trajectory optimization, motion control, vibration reduction). To this end he is able to formulate a mathematical model of the mechatronic system, the objective function and the constraints (e.g. in terms of position/velocity/acceleration, actuation limits, technological limits). While doing this he is able to make simplifying assumptions, and to make these assumptions explicit. Based on the mathematical formulation the student is able to recognize the nature of the optimization problem, select an appropriate numerical solution technique and apply this solution technique using existing software packages. The student is able to verify the validity of the obtained results, and is able to	1. Introduction - a number of motivating examples (control, fitting, planning) - mathematical modelling of optimization problems - the importance of convexity - classification of optimization problems 2. Algorithms for continuous optimization without limitations - the two basic strategies: line search or trust region techniques - gradient-based techniques: the steepest gradient and the added gradient method - Newton and quasi-Newton techniques - special methods for non-linea least square problems 3. Algorithms for continuous optimization with limitations - the KKT-optimization conditions - algorithms for linear problems: simplex-method and primal-dual interior point method		1) work out a number of optimization problems, apply numerical optimization techniques in guided problem sessions: − convex optimization − parameter estimation − application of constrained Gauss-Newton method − application of inequality constrained Gauss-Newton method and sequential quadratic programming 2) independent project work: formulate and solve a mechatronic optimization problem (individually or in a group of two students)

		critically evaluate and interpret the results (e.g. obtained accuracy, required calculation time) based on physical insight in light of the assumptions made.	- algorithms for quadratic problems: active-set technique and interior point method - convex optimization: formulation, the concept duality, algorithms - general non-linear optimization (penalizing and barrier techniques, connection to interior point algorithms) 4. A number of special optimization problems - stochastic optimization methods for problems with insecurities (corrective action, scenarios, stochastic LP) - Pareto-optimization for problems with multiple target functions - problems with discrete variables (branch-and-bound and cutting techniques) 5. Software - discussion of the possibilities of the most current optimization software-packages - sources on the internet: the Network Enabled Optimization Server		
	6.0 ECTS		**4.0 ects.**		**2.0 ects.**

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
4.	**H04P5A Embedded Control Systems**	This course introduces students to the software and hardware aspects of embedded and realtime computer-controlled machine tools, robots, vehicles and instruments, in the specific context of mechatronic systems-of-systems. Students will learn to fundamental concepts and techniques, and to understand how to apply them in embedded control systems, in order to later, in their professional live, be able to brainstorm with domain specialists. The students should learn to think and act as the "Chief Technical Officer" of an innovative technical company, responsible for the technical vision of the new embedded control products of the company. They have to apply the concepts and techniques of the lectures in the design of an innovative embedded control system.	**Embedded Control Systems.** Embedded Control Systems has several objectives, some non-technical: **Objective 1** This course is an introduction to embedded control systems, with an emphasis on the smart moving machines of the next generation, i.e., robots, cars, trucks, machine tools, airplanes, satellites, combine harvesters, etc. The objective is to introduce the students to the roles and responsibilities of innovation project engineers in companies that design and develop such embedded control systems. Actively striving to introduce “innovation” in a company is a very important attitude that the course wants to stimulate, with the design deliverable as the main outcome. **Objective 2** Within the very broad context of “embedded systems”, the course puts strong emphasis		To be defined by students and lecturer. The idea is to think about the design of a mechatronic system-of-systems that could become reality in five to ten years. Students are expected to come up with concrete descriptions of innovative designs, with a core contribution on the technical mechatronic aspects of that innovation, and with a SWOT analysis of their design, including at least two Milestones with measurable benchmarks.

			on: the systems-level thinking: every part of the system is selected and tuned for the goals of the whole system. innovative design: comparison of possible alternatives should be done on the basis of informed and motivated argumentations, and each design should clearly identify why it is “better” than what exists already. design automation: what standards and tools exist to support the design in large-scale projects, in which no single person can keep the overview and control of the whole design process. **Objective 3** The concrete contents of the course are detailed during the first lectures, in dialogue with the students. Indeed, students are expected to have a strong influence on these concrete course contents, since this is a perfect example of how, in their future professional live, they will be responsible for their company's initiatives, innovation and realisations!		

			A major aspect of this responsibility is that the students must make sure that they learn effectively and sufficiently, by pro-actively engaging in a constructively critical interaction with the teaching team and with their peers. In other words, learning is an continuous and conscious activity, so certainly not something one postpones until the examination period… **Learning targets** The course targets the following "ACQA indicators" used to describe learning objectives that courses should try to focus on and optimize (Source: Criteria voor Academische Bachelor en Master Curricula, P.M.M. Rullmann, R.A. van Santen, W.H.M. Zijm, 2005): Skilled in research: students are taught how to do research, that is, how to explore and structure new domains of knowledge in a systematic and goal-oriented way. Scientific approach: the		

			learning takes place via the formulation and motivation of hypotheses and models to explain the working of the "world", and the consequent corroboration or refutation of those hypotheses via confrontation with the factual reality and/or the input from more experienced peers. Takes temporal and societal context into account: knowledge only has added value in specific application contexts, and that value is often determined not only by technical properties but also by legal, ethical and societal values, norms and beliefs.		
	3.0 ECTS		**1.6 ects.**		**1.4 ects.**

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
5.	**H02A4A Robotics**	This course is an introduction to Intelligent Robotic Systems, i.e., machines that move (themselves and/or objects in their environment) and sense what is going on in their (immediate) neighbourhood, in order to achieve a given goal under uncertain environment conditions. The students are introduced to the fundamental structures, concepts, techniques, and algorithms in robotics, from the lower motion control level up to the higher 'Artificial Intelligence' levels. Since robotics is about integrating the best things from several research areas (mechanics, computer science, geometry, artificial intelligence, ...), relationships with other courses often occur, but we avoid overlaps as much as possible. The students are intensively stimulated to think and discuss as a researcher, since this course wants to prepare		This course is organized as guided self study: there is only one introductory lecture in class, and for the rest of the course the students work on a project of their own choice, in groups of two or three people. The project is chosen after consulting the lecturer. The students can opt for a rather theoretical course (discussing papers), or for a software project (studying a concrete robotics algorithm and implementing it in simulation or in an existing robot). The course has no organized examination session: it uses continuous evaluation, based on the students' inputs during the four or five one-hour interactive session with the lecturer. The students are expected to be able to digest and present the material in a very critical way, and to show their creativity in identifying appropriate applications, open problems, or inherent limitations in the studied material. The concept of the course allows	

		the interested students for a doctoral research carreer. - Students learn to analyse robotics applications from a system-level point of view, since robotics is very much a science of integration. - Students are stimulated to develop a critical, research-oriented attitude. - Students learn where to find reliable literature and other sources, and how to assess them. - Students study the deeper details of one or more aspects of the robotic system(s) they first learn analyse at a systems level.		to adapt its contents to the interests and background of the students. So, students and lecturer sit together at the beginning of the course to select a project topic that fits the students and that has sufficient robotics contents. However, the following Master programs get a specific treatment in that the contents is seamlessly adapted to their program: - Master in Artificial Intelligence: the emphasis is on "intelligent" control approaches for robot devices such as humanoids, walking robots, mobile robots, etc. - Master Werktuigkunde, cluster "Productie en Ontwikkeling": the emphasis is on the use of robots as production machines. - Master Werktuigkunde, cluster "Mechatronica en precisiemechanica": the emphasis is on the synergy between controllers for intelligent robots and for mechatronic devices. - Master Biomedische ingenieurstechnieken: the emphasis is on applying advanced kinematics and dynamics techniques from	

				robotics to the case of the human body, for analysis as well as synthesis (e.g., rehabilitation, operation planning, gait analysis, etc.). More information can be found on the course's webpage:	
	4 ECTS			**4 ects.**	

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
6.	**H06U9B Advanced Robot Control Systems**	Students will learn what are the fundamental components of advanced robot control systems, and how the robot must/can interact with its environment, and with the task it has to perform. Students will have insight in what are solved problems, and where the tough research challenges lie. Students will learn the robustness and integration issues that make the difference between a research robot prototype and an industrial robotics product. Students will be introduced to the large variety of complementary engineering domains that a systems level robot engineer has to be familiar with. Each student follows two hands-on sessions, on a real robot system in the lab. These sessions introduce the students to various complementary aspects of an advanced robot control system: kinematics, control, estimation, modelling, systems-level software engineering.	The following aspects of robot systems are introduced: kinematics and dynamics, control, task and motion specification, sensor-based world perception and task execution monitoring. A system-level insight is emphasised. This course is organized as guided self study: there are only a handful of lectures in class, and for the rest of the course the students work (individually) on a project of their own choice. That project is chosen after consulting the lecturers. The students can opt for a rather theoretical course (discussing papers), or for a software project (studying a concrete robotics algorithm and implementing it in simulation or in an existing robot). However, all students will have to follow two hands-on sessions, on a real robot system.		
	6 ECTS		**4 ects.**	**2 ects.**	

CURRICULUM ANALYSIS AT KTH ROYAL INSTITUTE OF TECHNOLOGY

Curriculum analysis for the Master's programme Mechatronics at KTH

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
	MF2031 Advanced prototyping	After completion of this course you will be able to: - describe the role of product prototyping in the product development process - describe the relation and the difference between virtual and physical prototypes - describe different methods to manufacture physical prototypes and when to select one before another - select a prototype method to manufacture a specific prototype and motivate this choice with respect to purpose, cost, time and quality - create 3D CAD models suitable for advanced prototyping methods - create a virtual and physical model based on reverse engineering technology - explain the relation and difference of various digital 2D/3D formats make a cost calculation and budget for a prototype development	- Introduction to Advanced - Protyping - Reverse engineering and - subtractive RP - Rapid prototyping processes and material selection - Geometric representation with 3D CAD models	Course project based on industry problems	- 3D printer - Milling - Scanner - Waterjet manufacturing
	6		**TEN2 - Examination, 3.0 credits**	**PRO5 - Project, 2.0 credits**	**LAB3 - Laborations, 1.0 credits**

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
2	**MF2042 Embedded Systems1 in Mechatronics**	After the course, students should be able to: - Provide examples of existing embedded systems based products and describe the special requirements placed in developing such systems. - Use modern integrated development environments for microcontroller/processor programming and their features for testing and debugging. - Understand the basics of Model-Based Development, and apply it in the context of embedded systems development. - Describe and explain the basic operation of microcontrollers/microprocessors, their internal features and peripherals. - Develop basic microcontroller programs for mechatronic applications, including the usage of I/O and communication peripherals. - Describe, explain and apply some of the basic concepts of communication protocols, in particular with reference to the Controller Area Network (CAN).	- Introduction to Embedded Systems - Programming is a Craft - Distributed systems - Power Management - Model-based Development - Embedded systems – Trends, opportunities and challenges		AVR32 Intro - Setting up the HW and SW - Creating your own program in AVR32 Studio - Debugging in AVR32 Studio Model-based development - Step by step tutorial
	6		**TEN1 - Written Exam, 4.0 credits**		**LAB1 - Laboratory Work, 2.0 credits**

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
3	**MF2007 Dynamics and Motion control**	At the end of this course, the student should be able to: Specify overall performance requirements for a motion control system. Understand the implication, and master the selection, of actuator and sensor components. Derive dynamic models of typical mechatronic applications. Find the correct parameters of dynamic models using experimental methods. Do dynamic analysis of the model in both frequency and time domain. Design model based feedback and model following control, i.e., servo control, both in continuous and discrete time. Do simulations of application and control system models in continuous and discrete time for the purpose of verification, performance analysis and	The course includes lectures to provide overview and inspiration, and laboratory work in which the participants work on a project. The project is modularized and parts of it are to be finalized each week of the course. The project work is done in groups of up to three to four participants. The course is concluded by oral presentations per group of the project work and by an individual written exam. - Course introduction - Modelling and analysis of dynamics as a basis for control design and simulation - Feedback control continuous time design - Feedback control discrete time control design - Model following control - servo design - Implement action of the controller on real-time hardware - Robustness to sensor noise	- Modeling of actuators and sensors - DC-Micromotors - Dynamics and motion control modeling - Position and velocity control	

		further devlopment Implement and structure the controller software for microprocessor implementation. Understand implementation restrictions due to sensor and actuator limitations and microprocessor resources such as computing speed, fixed vs. floating point arithmetic and memory. Design and use both digital and analogue filters.	and modeling errors		
	9		**TEN1 - Examination, 3.0 credits**	**PRO1 - Project, 6.0 credits**	

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
4	**MF2044 Embedded Systems 2**	This course aims to equip the participants with fundamental knowledge and practical skills for the development of embedded systems with emphasis on correctness by construction, verification, and debugging. This understanding means that You after the course should be able to: - Examplify embedded systems and their applications, describe the special requirements placed in developing such systems and the differences among different application domains (e.g. automotive, automation and medtech). - Describe and apply systematic approaches to system development including requirement specification, function design and realization, verification and validation. - Classify and explain different types of functionalities, behaviors, their corresponding	- Welcome to Embedded systems II - Embedded Control Systems Implementations - Anomalies, safety lifecycle, testing and debugging - System Design and Realization - Real-time task scheduling and execution; RTOS - Real-time Task Communications - Design for timing and dependability of distributed systems - Model-based development of embedded systems - Formal Verification with Model Checking		- Programming with CodeWarrior IDE and using the I/O card - Controller Implementation on a Coldfire Processor - Compiling and linking - Software Debugging - Using TrueTime to Simulate Embedded Control Systems - Real-Time Scheduling of Independent Periodic Tasks - Real-Time Task Communication and Synchronization with True Time - Simulating Distributed Embedded Control Systems with - TrueTime - Implementing realtime tasks with Rubus OS

		modeling techniques and implications on software, hardware, and real-time implementation. - Apply your knowledge in control theory and software programming in the design and implementation of control applications on distributed computers. - Describe, explain, and apply software platform technologies (real-time operating systems - RTOS). - Describe and explain fundamental techniques for verification and debugging, including how to derive test cases, and apply a subset of these techiques. - Analyze system requirements, derive the implied functional and nonfunctional constraints, and motivate architectural design and execution strategies using reference styles and patterns. - Understand the trends and state-of-the-art approaches to model- and component-based development of embedded systems.			
	6		**TEN1 - Written Exam, 3.0 credits**		**LAB1 - Laboratory Work, 3.0 credits**

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
5	**MF2063 Embedded Systems Design Project**	After the course, each student should be able to: - Apply knowledge and skills from earlier courses, as well as learn to acquire new ones on demand; - Identify, compare and critically assess aspects of an engineering problem, towards making design decisions; - Use professional tools and processes necessary for the development of embedded systems; - Learn to get organised, manage, lead and become part of a cross technical and complex development project. - The student should after the course have good technical understanding, knowledge and skill in - Methods and tools for co-design and optimization of embedded systems; - Working through all aspects of an engineering development process; - designing and	The course focuses on product development of embedded systems in industrially relevant design projects. The ability to create embedded systems is primarily created by developing knowledge and skills in subjects such as software engineering, real-time programming, electronics engineering and distributed systems, complemented by application domain specific skills such as motion control, signal processing and human-machine interfaces. - Introduction to Embedded Systems Design Project - Assignment: Prestudy Image, Position Sensor Idea – Hermes - Integrated Transport Research Lab - Interfleet Technology AB	PRO1. Higher course project for Interfleet - Embedded system implantation of new method for battery monitoring Workshop1 - A Development Process for - Embedded Control Systems Workshop2 - Model-Based Development for Embedded Systems	

		implementing prototypes. - Being part of a larger engineering project, the student will learn how to - Apply a model-based development approach to embedded systems development; - Apply a fundamental test process; - Apply a requirements management method with considerations taken to the life-cycle concerns of embedded systems based products.			
	9				

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
6	**MF2058 Mechatronics Advanced Course part 1**	Mechatronics Advanced Course aims to provide the student with the professional skills needed to create innovative mechatronics products and work with complex product development. This multidisciplinary work is realized by combining mechanical design, with control-, electronics- and software engineering. The student should after the course be able to: - apply knowledge and skills from earlier courses, as well as learn to acquire new ones on demand; - identify, compare and critically assess aspects of an engineering problem, towards making design decisions; - describe, compare and critically examine various product development processes and their properties; - apply and evaluate support	The course focuses on product development, of mechatronic products, in large projects. Innovative and intelligent products are created by developing knowledge and skills in motion control, robotics, embedded systems, real-time programming, distributed systems. The course is based on problem based learning and work in large projects, where the ability to engage in professional development while developing cooperation, communication and project management is practiced. Lecture includes: - Project Management - Product Development Processes - Lean development - History, examples and its application - Requirements Engineering - Mechatronics Engineering - Experiences from Earlier - Projects	PRO1 – Project •Requirements Engineering •Document Management •Development processes •Verification, Validation & Testing •Life cycle thinking in product development •Diversity and inclusion in organization PRO2 - Project	

		methods in complex product development; - use professional tools and processes necessary for the development of mechatronics products; - learn to get organised, manage, lead and become part of a cross technical and complex development project. - The student should after the course have good technical understanding, knowledge and skill in - modelling, simulation and visualization of dynamic products and systems; - methods and tools for co-design and optimization of mechatronic systems; - working through all aspects of an engineering development process; - designing and implementing prototypes. - Further, the student should be able to work through all aspects of an engineering development process: - apply and use professional tools and methods for product development; - use modern and relevant	- Verification, Validation & Testing - Diversity and inclusion in organization - Embedded systems testing at Scania – study visit - Document management - Life cycle thinking in product development - Project Management in Practice – A study visit to Å		

		working methods; - apply a Model-based development approach to mechatronics product development; - apply a fundamental test process; - apply a requirements management method.			
	9		**TEN1 - Written Exam, 3.0 credits**	**PRO1 - Project, 3.0 credits** **PRO2 - Project, 3.0 credits**	

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
7	**MF2070 Introduction to Engineering Design**	The course gives an overview of scientific and industrial development trends within the areas of engineering design and industrial design. Scientific working methods, research methodologies and research and engineering ethics are treated both on a general level, and on the level of specific research domains. Focus is on how research may be used for the benefit of industry and society by promoting innovation. Scientific writing, reviewing and presentation to an international audience are taught.	The course is given in the form of seminars, workshops and an industrial visit. The seminars are led by professors renowned for their research competence and their collaboration with industry. During a number of workshops, students prepare the seminars and discuss research methods in groups. An industrial visit serves the purpose of providing an industrial perspective on engineering design and research methods: Track Introductions(incl. team creation, Industrial Visit sign-up) Machine Design, Internal -Engineering Research Methodology Combustion Engines, -Tribology Mechatronics, IDE -Quantitative methods in mechatronics research - Kick-off Competition - Industrial Site Visits to: - FMV, Interfleet Technology, Maquet, Scania, ÅF - Workshop(Quantitative		

			Methods) - Workshop(Qualitative Methods) - Workshop(Theory of Science) - Theory of Science (joint session) - Theory of Science (parallel seminar sessions) - Feedback on written report		
	3			**PRO1 - project Work, 3.0 credits**	

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
8	**MF 2043 Robust mechatronics**	The overall aim of the course is to provide deeper understanding of mechatronic design with respect to hardware After this course you should be able to: 1. Design a mechatronic system that is robust and takes into account EMC. 2. Design power supply modules and analogue/digital signal conditioning for microcontrollers 3. Take into account the interference between mechanical and electrical design 4. Design and implement anlogue and digital filters After this course you should have knowledge about: 1. Standards and directives 2.Environmental sustainability for electronics 3. When in the development process it is necessary to take the robustness into account 4. Structured fault diagnosis. 5. Printed circuit board design and soldering 6. Signal conditioning inside the microcontroller	The overall aim of the course is to provide deeper understanding of mechatronic design with respect to hardware. - Introduction and system level - Power supply -Interfaces for µ-Controllers Actuators -Analogue and Digital Interfaces for µ-Controllers Sensors - Designing and implementing filters in mechatronic systems -Introduction to Electro Magnetic Compatibility - EMC 2 -AirContainer -Digital interfaces for µ-Controllers -Assembly of mechatronic systems. Troubleshooting -Lab resume -Design of electronics systems for harsh environments		- Soldering technique - Power supply - Filter - Interface actuators - Interface sensors - Integration
	6		**Written Exam, 4 credits**		**Exercises 2 credits**

#	Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
9	**MF2030 Mechatronics basic courses**	The course gives an overview of the basics of mechatronic systems and products including the components and characteristics typical for such systems. The course introduces a mechatronics design procedure and provides insight into both advantages and difficulties of mechatronics design. The overall aim is that the students in relevant subsequent courses will apply this design procedure and in a stepwise manner deepen their proficiency in using it. After completion of the course the students should be able to: 1. Describe the basic building blocks of mechatronic systems (e.g. hardware, software, communication, interfacing, sensing, control and actuation). 2. Discuss if a mechatronic design might be feasible as a solution to a given functional problem formulation. 3. Sketch such a technical solution and select component types. 4.Identify critical problems/design issues and suggest feasible methods and tools to solve those.	The lectures cover the main course content and are supported by lecture notes (slides). One lecture is devoted to an industrial guest lecturer, one to a more futuristic outlook for the mechatronics field and one to student presentations of assignments. The course introduces and gives examples of mechatronic products and the various components, design alternatives, methods and tools used in mechatronics design. Real mecahtronic design problems are identified and solved. -Introduction to the course and to the subject of mechatronics - Modeling of mechatronic systems, basic concepts - Control basics - Modeling of mechatronic systems continued - Multi-body systems modeling -Frequency domain analysis via transfer functions - Sensors, actuators and related Components - Control implementation aspects More on control		

		5. Be able to summarize and on smaller problems apply a development model for mechatronic product development. 6. Model, simulate and synthesize (but not realize) smaller mechatronic systems and products. 7. Give several examples of additional (not directly functional) product requirements typically important for mechatronic products and summarize on a course level the implications of those requirements on the product design.			
	6		**Written Exam, 3 credits**		**Assignments, 3 credits**