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Content

KEYNOTE LECTURES

Konstantinos-Dionysios Bouzakis	
CHARACTERIZATION METHODS AND PERFORMANCE OPTIMIZATION OF COATED CUTTING TOOLS	3
Manfred Hild	
DEFYING GRAVITY – A MINIMAL COGNITIVE SENSORIMOTOR LOOP WHICH MAKES ROBOTS WITH ARBITRARY MORPHOLOGIES STAND UP	23
Niko Herakovic	
DEVELOPMENT TRENDS IN ASSEMBLY AUTOMATION ANFLUID POWER	35
Giovanni Belingardi	
LIGHTWEIGHT DESIGN OF VEHICLE BODY A CONTRIBUTION TOWARD GREENER ENVIRONMENT	49
Dušan Gruden	
QUESTION THAT IS ASKED FOR DECADES: WHO WILL MOVE OUR CARS IN THE FUTURE?	55

MECHANICS AND DESIGN

1 Djordjevic Zorica, Blagojevic Mirko, Kostic Nenad, Jovanovic Sasa, Marjanovic Vesna	
ADVANTAGES OF APPLICATION COMPOSITE MATERIALS FOR PRODUCTION CARDAN SHAFTS	71
2 Tihomir Mackic, Živko Babic, Mirko Blagojevic, Goran Jotic, Jovan Škundric	
AN ANALYSIS OF LUBRICATION REGIME BETWEEN THE CONTACT ELEMENTS OF CYCLOID REDUCER	77
3 Stevan Maksimovic, Ivana Vasovic, Mirko Maksimovic, Mirjana Djuric	
ANALYSIS OF AICRAFT STRUCTURES WITH RESPECTS TO FATIGUE AND FRACTURE MECHANICS	83
4 Pejašinovic Živko, Jotic Goran, Mackic Tihomir	
ANALYSIS OF ELASTIC ELEMENTS PROPERTIES OF AXIAL FORCE TRANSDUCERS	89
5 Radomir Djokic, Jovan Vladic, Dragan Živanic	
ANALYSIS OF POWER TRANSMISSION SYSTEMS FOR ELEVATORS AND DYNAMIC MODELS	95
6 Ljupco Trajcevski, Tale Geramitchioski	
ANALYTIC SIMULATION OF DAMAGE OF GEAR TOOTH	101
7 Nenad Marjanovic, Nenad Kostic, Mirko Blagojevic, Vesna Marjanovic, Biserka Isailovic	
AUTOMATED GEAR TRAIN MODELING IN CAD ENVIRONMENT	107

8	Gordana Bogdanovic, Dragan Milosavljevic, Ljiljana Veljovic, Aleksandar Radakovic	
	COMPOSITE MATERIALS – MECHANICAL BEHAVIOR OF ANISOTROPIC MEDIA	111
9	Nijaz Hasanagic, Asim Jušić, Milan Jurkovic, Mladen Todic	
	DESIGNING TRANSDUCERS FOR MEASUREMENT OF FORCE IN SHEET METAL FORMING PROCES BY MEANS OF ROLLERS	115
10	Matejic S. Miloš, Veljovic Ljiljana, Marjanovic Vesna, Blagojevic Mirko, Marjanovic Nena	
	DYNAMIC BEHAVIOR OF PLANETARY GEARBOX NEW CONCEPT	121
11	Filip Zdraveski, Ivan Mickoski, Dimitri Kozinakov	
	EXPLORING THE PERFORMANCE OF TUNED MASS DAMPERS-TMD IN MULTY STOREY BUILDINGS	127
12	Aleksandar Borkovic	
	FREE VIBRATION ANALYSIS OF STIFFENED THIN-WALLED STRUCTURES	133
13	Aleksandar Borkovic	
	GEOMETRIC NONLINEAR ANALYSIS OF STIFFENED PLATES USING THE COMPOUND STRIP METHOD	141
14	Ljiljana Veljovic, Dragan Milosavljevic, Gordana Bogdanovic, Aleksandar Radakovic	
	MODELING AND ANALYSIS FOR THE VIBRATION OF A GYROROTOR	149
15	Aleksandar Živkovic, Milan Zeljkovic, Slobodan Tabakovic	
	NONLINEAR MATHEMATICAL MODEL TO DETERMINE THE STIFFNESS OF THE AUTOMOTIVE WHEEL BEARING	155
16	Daniela Ristic, Dragan Milosavljevic	
	NUMERICAL MODEL FOR THE CRITICAL STRESS DETERMINATION IN SPUR GEARS – CASE OF A DRIVEN GEAR	163
17	Strain Posavljak, Katarina Maksimovic, Slobodanka Boljanovic	
	ON IMPORTANCE OF GEOMETRY AND CYCLIC MATERIAL PROPERTIES IN DESIGN OF FATIGUE RESISTANT TURBOJET ENGINE ROTATING DISKS	169
18	Miloš Ristic, Milosav Ognjanovic	
	PLANETARY GEAR TRANSMISSION SET DESIGN WITH UNIFORM RELIABILITY LEVEL	179
19	Enes Mujanovic, Denijal Sprecic	
	POSSIBILITIES OF THE APPLICATION OF MACHINE VISION IN THE ANALYSIS OF THE MICROSTRUCTURE OF DAMAGED MECHANICAL PARTS	185
20	Aleksandar Radakovic, Dragan Milosavljevic, Gordana Bogdanovic, Ljiljana Veljovic, Srba Aleksandrovic	

	SECOND-ORDER FAILURE CRITERIA IN LAMINATE INCLUDING THE EFFECT OF SHEAR STRESS	193
21	Miloš Djordjevic, Nenad Zrnica, Milorad Pantelic SIMPLIFIED LIFE CYCLE ASSESSMENT OF A RETURN BELT CONVEYOR IDLER	201
22	Radivoje Mitrovic, Nataša Soldat, Žarko Miškovic, Nebojša Matic SOME EXPERIENCES IN LABORATORY TESTING OF BEARINGS OF TRANSPORT IDLERS ON BELT CONVEYOR	207
23	Slobodanka Boljanovic, Stevan Maksimovic, Strain Posavljak STRENGTH ANALYSIS OF DAMAGED STRUCTURAL COMPONENTS	213
24	Drago Blagojevic, Mladen Todica, Valentina Golubovic-Bugarški STRESS STATE OF RAIL VEHICLE WHEEL RIM IN EXPLOATATION	221
25	Andreja Ilic, Lozica Ivanovic, Danica Josifovic, Vukic Lazic, Boris Rakic TESTING OF ELEMENTS AND JOINTS AT MECHANICAL CONSTRUCTIONS	231
26	Dragi Stamenkovic, Katarina Maksimovic, Slobodanka Boljanovic THE EFFECTS OF RESIDUAL STRESSES TO CRACK GROWTH RATE OF WELDED STRUCTURAL COMPONENTS	237
27	Srdjan Bošnjak, Zoran Petkovic, Miodrag Arsic, Nebojša Gnjatovic, Ivan Milenovic BUCKETS OF THE BUCKET WHEEL EXCAVATORS: FAILURES AND REDESIGN	243
28	Srdjan Bošnjak, Zoran Petkovic, Nebojša Gnjatovic, Vaso Mihajlovic, Goran Milojevic STRENGTH PROBLEMS OF THE TRAVELLING MECHANISMS OF THE OPEN PIT MACHINES	249

PRODUCTION TECHNOLOGIES AND ENGINEERING

1	Branko Pejovic, Slavica Cvetkovic, Pantelija Dakic, Aleksandar Todica, Stefan Pavlovic ABOUT A SUITABLE MODEL OF KINEMATIC ANALYSIS OF COMPLEX MACHINE TOOLS TRANSMITTERS	257
2	Bogdan Maric, Ranko Božickovic, Miloš Sorak, Zdravko Božickovic ALGORITHM FOR PRODUCTION PROCESS MANAGEMENT IN OVERHAUL PRODUCTION SYSTEM	269
3	Bogdan Nedica, Marko Jankovic, Miroslav Radovanovic, Gordana Lakic Globocki AN INVESTIGATION OF QUALITY IN PLASMA CUTTING	275
4	Jovišević Vid, Borojević Stevo, Globocki-Lakic Gordana, Cica Djordje, Sredanović Branislav ANALYSIS OF EFFECTIVENESS ON PRODUCTION SYSTEM FOR PRODUCTION OF THE TOOLS FOR HYDRAULIC PRESS BRAKES	283

5	Milan Despotovic, Zoran Kovacevic, Jasna Radulovic ANALYSIS OF OPTIMAL WIRING OF PV PANELS BY MEANS OF NONLINEAR INTEGER PROGRAMMING	291
6	Dragan Adamovic, Vesna Mandic, Milentije Stefanovic, Srbislav Aleksandrovic, Miroslav Živkovic ANALYSIS OF THE TEMPERATURE CHANGE ON THE TOOL AND WORK PIECE DURING THE IRONING PROCESS	299
7	Marin Gostimirovic, Dragan Rodic, Pavel Kovac, Vladimir Pucovsky, Branislav Savkovic APPLICATION OF NEURO-FUZZY SYSTEMS AND GENETIC PROGRAMMING FOR MODELLING SURFACE ROUGHNESS IN ELECTRICAL DISCHARGE MACHINING	307
8	Dušan Petkovic, Goran Radenkovic, Vladislav Blagojevic, Predrag Živkovic, Ivan Ciric APPLICATION OF REGRESSION ANALYSIS AND GENETIC ALGORITHM TO THE OPTIMIZATION OF NITRIC ACID PASSIVATION OF 316L STAINLESS STEEL	313
9	Simo Jokanovic, Slaviša Todorovic AUTOMATIC GENERATION OF 3D CAD MODELS OF STANDARD PARTS AND PRODUCTS BY APPLICATION PROGRAMMING INTERFACES OF CAD/CAM SYSTEMS	319
10	Mathias Liewald, Ranko Radonjic BEHAVIOR OF ADVANCED HIGH STRENGTH STEELS IN DEEP DRAWING PROCESSES	325
11	Dragoslav Dobraš, Žarko Petrovic, Zdravko Božickovic BROWN'S GAS – HEAT SOURCE FOR WELDING	333
12	Zoran Janjuš, Aleksandar Petrovic, Aleksandar Jovovic, Radica Prokic- Cvetkovic CHANGES MECHANICAL PROPERTIES POLYPROPYLENE FILLED GLASS POWDER	339
13	Milena Cosic, Marina Dojcinovic, Zagorka Acimovic-Pavlovic CHARACTERIZATION OF THE MICROSTRUCTURE EVOLUTION IN RHEOCAST HYPEREUTECTIC AL-SI ALLOY	345
14	Vladan Andonovic, Marija Ackovska, Neda Petroska Angelovska CLOUD COMPUTING AS INTERNET OF THINGS PARADIGM FOR BIOMEDICAL INVESTIGATION	351
15	Slobodan Petricevic, Marko Barjaktarovic, Pedja Mihailovic COATED BOARD INSPECTION SYSTEM	357
16	Velimir Todic, Dejan Lukic, Mijodrag Miloševic, Jovan Vukman, Goran Jovicic COMPUTER AIDED CONCEPTUAL PROCESS PLANNING – A SHORT REVIEW	367

17 Dejan Lukic, Velimir Todic, Mijodrag Milošević, Goran Jovicic, Jovan Vukman	SOFTWARE DEVELOPMENT FOR CONCEPTUAL PROCESS PLANNING	375
18 Dejan Lukic, Velimir Todic, Mijodrag Milošević, Jovan Vukman, Goran Jovicic	VERIFICATION OF THE DEVELOPED CONCEPTUAL CAPP SYSTEM ON THE EXAMPLE OF ROLLER BEARING	383
19 Branislav Sredanovic, Gordana Globocki Lakic, Davorin Kramar, Janez Kopac	CUTTING FORCE MODELING IN HARD ALLOY STEEL TURNING	389
20 Srbislav Aleksandrovic, Tomislav Vujinovic, Milentije Stefanovic, Vukic Lazic, Milan Djordjevic, Dragan Milosavljevic	DEFINING OF PRESSURE AND DRAWBEAD HEIGHT FUNCTIONS IN SHEET METAL STRIPE TENSILE TEST OVER DRAWBEAD WITH VARIABLE PARAMETERS	397
21 Mladen Todic, Ostoja Miletic	DEFORMATION ZONES AT TWO-LAYER BENDING COMPOSITES	403
22 Dimitri Kozinakov, Filip Zdraveski	DETERMINATION OF STIFFNESS CLASS OF SPIRAL PIPES VIA TEST METHOD AND COMPARISON WITH COMPUTER MODEL RESULTS	409
23 Mileta Janjic, Sreten Savicevic, Milan Vukcevic, Nikola Šibalic	DETERMINATION OF STRAIN RATE STATE AT FORGING IN OPEN DIE	417
24 Asim Jušić, Nijaz Hasanagic, Milan Jurkovic, Mladen Todic	ELASTIC STRAIN TEST FRAME OF PROCESSING SYSTEM FOR PROFILING SHEET METAL BY ROLLERS	423
25 Petar Tasic, Ismar Hajro, Damir Hodžić, Dragoslav Dobraš	ENERGY EFFICIENT WELDING TECHNOLOGY: FSW	429
26 Igor Kacmarcik, Miroslav Plancak, Dragiša Vilotic, Dejan Movrin, Aljoša Ivanišević	IMPACT OF BILLET SHAPE ON FORGING LOAD AND MATERIAL FLOW IN BI-METALLIC FORWARD Al/Cu EXTRUSION	443
27 Milentije Stefanovic, Vesna Mandic, Zvonko Gulišija, Srbislav Aleksandrovic, Dragan Adamovic	IMPROVING THE QUALITY OF AL – ALLOYS HOT FORGING PARTS	447
28 Adnan Mustafi c, Sladjan Lovric, Edis Nasic, Mirza Krajnovic	INFLUENCE OF POROUS STAINLESS STEEL OBTAINED BY CENTRIFUGAL CASTING ON THE CUTTING ABILITY OF BANDSAW TOOLS	453
29 Isak Karabegovic, Bekir Novkinic, Ermin Husak, Safet Isic	INFLUENCE OF SELF-EXCITED VIBRATIONS ON THE SURFACE ROUGHNESS OF WORKPIECES OBTAINED BY LONGITUDINAL TURNING	459

30	Aljoša Ivanišević, Dejan Movrin, Igor Kacmarcik, Branko Štrbac, Milorad Betegalo	
	INVESTIGATION OF NEGATIVE SPRING BACK IN V – BENDING OPERATIONS	465
31	Mirza Krajnovic, Adnan Mustafi c, Mensur Demirovic	
	MODELING OF ELASTIC STRAIGHTENING IN THE PROCESS OF PRODUCTION OF COIL (HELICAL) CYLINDRICAL SPRINGS	483
32	Dusan Jovanic, Zeljko Eremic	
	MODELLING DATABASE OF WELDING PROCEDURE SPECIFICATION	479
33	Sekulic Milenko, Kramar Davor, Kopac Janez, Gostimirovic Marin, Kovac Pavel	
	OPTIMIZATION CUTTING PARAMETERS BASED ON CUTTING TEMPERATURE IN HPJA TURNING PROCESS USING TAGUCHI'S METHOD	487
34	Dijana Nadarevic, Davorin Kramar, Mirko Sokovic	
	PLANNING OF THE CRANKSHAFT GRINDING PROCESS	493
35	Ivan Matin, Miodrag Hadzistevic, Janko Hodolic, Djordje Vukelic	
	PRACTICAL ASPECTS OF INTEGRATION IN THE DEVELOPED MOLD DESIGN SYSTEM	501
36	Slobodan Tabakovic, Mirjana Bojanic, Milan Zeljkovic, Zoran Milojevic	
	PROGRAMMING SOLUTIONS FOR PROCESSING DIGITAL MEDICAL IMAGES	507
37	Saša Živanovic, Miloš Glavonjic	
	SIMULATIONS OF MACHINING BASED ON STEP-NC	513
38	Borut Kosec, Mirko Sokovic, Gorazd Kosec, Blaž Karpe	
	THERMOGRAPHIC AND FAILURE ANALYSIS OF DIES FOR ALUMINIUM AL-LOYS DIE-CASTING	523
39	Emilia Assenova, Mara Kandeva	
	TRIBOLOGY CENTER AT THE TECHNICAL UNIVERSITY – SOFIA	531
40	Dragoslav Dobraš, Zdravko Božickovic, Žarko Petrovic, Mladen Santrac, Petar Tasic	
	VIRTUAL WELDING	537
41	Goran Janjic, Zorana Tanasic, Aurilla Aurelie Arntzen Bechina	
	EFFECTIVE MANAGEMENT OF PERSONNEL DEVELOPMENT IN BUSINESS SYSTEMS	543

ENERGY AND THERMAL ENGINEERING

1	Jasmina Skerlic, Milorad Bojic, Danijela Nikolic, Jasna Radulovic, Dragan Taranovic	
	A KEY REVIEW ON EXERGETIC ANALYSIS AND ASSESSMENT OF SOLAR ENERGY SYSTEMS FOR A SUSTAINABLE FUTURE	553

2	Suad H. Suljkovic, Velimir P. Stefanovic, Saša R. Pavlovic, Marko Ilic A REVIEW OF STRATEGIES AND TECHNOLOGIES TOWARDS NET ZERO ENERGY BUILDINGS THROUGH EXAMPLES ALL OF THE WORLD	561
3	Gordana Tica, Azra Rogovic-Grubic, Kotur Milovan, Petar Gvero AN ANALYSIS OF THE USE OF HCFC – REFRIGERANTS IN THE INDUSTRY AND HOUSEHOLDS IN BOSNIA AND HERZEGOVINA. A REVIEW OF POSSIBLE ALTERNATIVE REPLACEMENTS	567
4	Vladimir V. Jovanovic, Mirko S. Komatina, Dragoslava D. Stojiljkovic, Nebojša Manic APPLICATION OF FUEL FACTOR FOR CALCULATION OF FLUE GAS FLOW RATE IN TPP KOSTOLAC	575
5	Vesna Rankovic, Milorad Bojic, Aleksandar Novakovic, Marko Miletic, Nenad Kostic BUILDING CONTROLLER SYNTHESIS BASED ON THE USE OF MLE+CO- SIMULATION TOOL	583
6	Dušan Gordic, Gordana Stojanovic, Ana Radojevic COMPARATIVE ANALYSIS OF ENERGY INDICATORS IN SCHOOLS IN THE TERRITORY OF THE CITY OF KRAGUJEVAC	589
7	Bosko Bacic, Milan Lecic, Indir Mujanic COMPARATIVE ANALYSIS OF SOME METHODS FOR THE CALCULATION OF HEAT TRANSFER COEFFICIENT DURING THERMAL CALCULATION OF EVAPORATOR WITH NATURAL CIRCULATION	599
8	Marko Miletic, Ivan Miletic, Dragan Cvetkovic, Nenad Kostic, Milorad Bojic COMPARISON OF BUILDING ENVELOPE TYPES DEPENDING ON THE THER-MAL INSULATION LAYER POSITION	605
9	Nenad Kostic, Mirko Blagojevic, Vesna Marjanovic, Marko Miletic, Milorad Bojic DETERMINING SOLAR ANGLES FOR SUN TRACKING SYSTEM DEVELOPEMENT DURING SPECIFIC TIMES OF THE YEAR	613
10	Aleksandar Novakovic, Vesna Rankovic, Nenad Grujovic, Dejan Divac, Nikola Milivojevic DEVELOPMENT OF NEURO-FUZZY MODEL FOR DAM SEEPAGE ANALYSIS	619
11	Marko Mancic, Dragoljub Živkovic, Velimir Stefanovic, Vladana Stankovic, Goran Jovanovic DYNAMICAL SIMULATION OF A SOLAR-HEAT PUMP SYSTEM FOR ON- SITE ELECTRICITY PRODUCTION	625
12	Elvis Hozdic, Milan Jurkovic, Sulejman Kendic ECOLOGICAL SOLID WASTE DISPOSAL AND EXPLOITATION OF LANDFILL GAS	631
13	Ranka Radic, Aleksandra Stanivukovic, Semin Petrovic, Brian Schjertzer, Petar Gvero	

	EMISSION REDUCTION MEASURES IN LOCAL COMMUNITIES IN B&H AS A RESULT OF SIGNING COVENANT OF MAYORS	643
14	Boris Cosic, Antun Pfeifer, Neven Duic ENERGY SYSTEM PLANNING WITH A HIGH SHARE OF RENEWABLE ENERGY SOURCES: THE CASE STUDY OF BOSNIA AND HERZEGOVINA	649
15	Mica Vukic, Jelena Janevski, Goran Vuckovic, Mirko Dobrnjac EXPERIMENTAL INVESTIGATION ON DRYING KINETICS OF CORN IN PACKED AND FLUIDIZED BED	657
16	Sadoon Ayed, Miloš Jovanovic, Gradimir Ilic, Predrag Živkovic, Mica Vukic, Mirko Dobrnjac, Suzana Kljecanin EXPERIMENTAL STUDY OF TEMPERATURE DISTRIBUTION FOR TURBULENT RAYLEIGH–BÉNARD CONVECTION IN A RECTANGULAR TAN	665
17	Danijela Kardaš, Petar Gvero, Mario Katalinic HEAT PUMP USING WASTE WATER AS A HEAT SOURCE – Student centar „Nikola Tesla“ BANJA LUKA	673
18	Nenad Miloradovic, Ivan Miletic, Marko Miletic, Dragan Cvetkovic, Milorad Bojic INFLUENCE OF PROPER WINDOW SELECTION ON ENERGY CONSUMPTION DURING A YEAR	679
19	Andreevski Igor, Kanevce Gligor, Kanevce Ljubica, Stavreva Sevde, Popovski Kire INVERSE ESTIMATIONS APPLICATION IN THE FIELD OF DISPERSION MODELING	687
20	Mladen Tomic, Predrag Živkovic, Mica Vukic, Mirko Dobrnjac, Gradimir Ilic MATRIX HEAT EXCHANGERS AND THEIR APPLICATION	693
21	Danijela Nikolic, Milorad Bojic, Jasmina Skerlic, Jasna Radulovic, Dragan Taranovic MODELLING OF HYBRID VENTILATION SYSTEM IN BUILDINGS USING ENERGYPLUS SOFTWARE	703
22	Sevde Stavreva, Marko Serafimov, Igor Andreevski, Cvete Dimitrievska USE OF CFD ANALYSIS TO ACHIEVE ENERGY EFFICIENT DATA CENTER	709
23	Igor Shesho, Dame Dimitrovski, Marko Serafimov NEARLY ZERO ENERGY BUILDINGS (nZEB), PLANNING AND POSSIBILITIES FOR APPLICATION	715
24	Žana Stevanovic, Gradimir Ilic, Mica Vukic, Predrag Živkovic, Ivan Lazovic NUMERICAL SIMULATION OF COANDA EFFECT IN MECHANICAL AND VENTILATED OFFICE	721
25	Alexandre Patou-Parvedy, Milan Despotovic OPTIMAL COMPOSITION AND THICKNESS OF THE ABSORBER WALL OF THE SOLAR CHIMNEY	727

26	Novak Nikolic, Nebojša Lukic, Dragan Taranovic OPTIMAL REFLECTOR POSITION OF A DOUBLE EXPOSURE FLATPLATE SOLAR COLLECTOR	737
27	Marko Miletic, Saša Jovanovic, Zorica Djordjevic, Ivan Miletic, Milorad Bojic OPTIMISATION OF ZERO-NET ENERGY HOUSE ORIENTATION FROM SOLAR ENERGY ABSORPTION ASPECT	743
28	Svetlana Dumonjic-Milovanovic, Petar Gvero OPTIMIZATION OF HYBRID SYSTEM FOR ELECTRICITY PRODUCTION BASED ON WIND AND SUN ENERGY CONVERSION WITH ANALYSIS OF ITS APPLICABILITY ON BANJALUKA REGION	749
29	Dragan Cvetkovic, Milorad Bojic, Vesna Rankovic, Marko Miletic, A. P. Parvedy OPTIMIZATION OF THE THERMAL INSULATION OF THE RADIANT PANELS	755
30	Marko Ignjatovic, Bratislav Blagojevic, Mladen Stojiljkovic, Mirko Stojiljkovic, Aleksandar Andjelkovic PRIMARY ENERGY CONSUMPTION DURING HEATING SEASON OF AN OFFICE BUILDING WITH ATTACHED DOUBLE SKIN FAÇADE	765
31	Kire Popovski, Stojance Nusev, Igor Andreevski RING-TYPE WATER SUPPLY NETWORKS	775
32	Djordjevic Zorica, Jovanovic Sasa, Bojic Milorad, Cvetkovic Dragan, Adamovic Dragan THE INFLUENCE OF ELECTRICAL APPLIANCES ON SPENDING ENERGY IN HOUSEHOLDS	779
33	Milovan Kotur, Franc Kosel, Šajn Viktor THE MATHEMATICAL ALGORITHM FOR A MULTI-CHANNEL CTA ANEMOMETER IN SPHERICAL COORDINATES	785
34	Vladimir Cavic, Petar Gvero THE USE OF AGRICULTURAL WASTE FOR A SUSTAINIBLE ENERGY SUPPLY FOR GREENHOUSE PRODUCTION	791
35	Jasna Radulovic, Milorad Bojic, Danijela Nikolic, Jasmina Skerlic, Dragan Taranovic THE USE OF PV IN NET-ZERO ENERGY BUILDINGS: CHALLENGES AND PERSPECTIVES	797
36	Vanja Šušteršič, Slobodan Savic, Dušan Gordic THE USE OF WASTE HEAT FROM WASTEWATER TREATMENT PLANT IN RURAL HOUSEHOLDS WITH HEAT PUMP	803
37	Predrag Živkovic, Mladen Tomic, Dušan Petkovic, Ivan Ciric, Mirko Dobrnjac, Velimir Stefanovic, Žana Stevanovic WIND ENERGY POTENTIALS OF VLASINA REGION	809
38	Andreja Stefanovic, Dušan Gordic ZERO CARBON HOMES, COGENERATION AND ORGANIC AGRICULTURE AS A METHODS OF REDUCING CO ₂ EMISSIONS	815

TRANSPORT AND MEANS OF TRANSPORT

- 1 Velimir Petrovic, Vladan Popovic, Branka Grozdanic, Zlata Bracanovic, Slobodan Jankovic
A NEW METHOD FOR PARTICLE APPROVAL TYPE TESTING FOR HEAVY DUTY DIESEL ENGINE 823
- 2 Milan Milovanovic
A RISK OR CONVENIENCE OF APPLYING AVAILABLE GAS SYSTEMS 829
- 3 Mirsad Trobradovic, Boran Pikula, Ivan Filipovic, Dževad Bibic
AUTOMATED TRANSMISSION – A CHALLENGE FOR THE FUTURE 837
- 4 Hristijan Mickoski
ANALYZE OF INFLUENCE OF VARIOUS FACTORS TO THE BRAKING ROAD OF RAIL VEHICLES, MODELLING AND SIMULATION IN MATLAB/SIMULINK 843
- 5 Izudin Delic, Izet Alic, Midhat Osmic
CFD ANALYSIS OF STREAMING CHARACTERISTICS OF VARIABLE GEOMETRY TURBOCHARGER 849
- 6 Predrag Mrdja, Vladimir Petrovic, Nenad Miljic, Slobodan Popovic, Marko Kitanovic
COMBUSTION PARAMETERS CALIBRATION AND INTAKE MANIFOLD REDESIGN FOR FORMULA STUDENT YAMAHA YZF-R6 ENGINE 855
- 7 Riste Temjanovski
COMPETITIVENESS TRANSPORT SYSTEM AS A NECESSARY PRECONDITION FOR A SUCCESSFUL EUROPEAN INTEGRATION: MACEDONIAN CASE 861
- 8 Saša Milojevic, Jovanka Lukic, Radivoje Pešic
CONTRIBUTION TO THE REDUCTION OF TRAFFIC NOISE BY APPLICATION OF THE CNG BUSES 873
- 9 Radivoje Pešic, Aleksandar Davinic, Dragan Taranovic
ECOLOGICAL AND ENERGY ENGINE CHARACTERISTICS WHEN THE ENGINE APPLIES DIFFERENT WORKING PROCESSES 879
- 10 Slobodan Mišanovic
EXPERIENCES OF PUBLIC TRANSPORT COMPANY "BELGRADE" IN THE USE OF ALTERNATIVE FUELS AND ENVIRONMENTALLY CLEAN VEHICLES IN URBAN PUBLIC TRANSPORT 887
- 11 Slobodan Popovic, Nenad Miljic, Marko Kitanovic, Predrag Mrdja, Miroljub Tomic
HIGH-FIDELITY, ANGLE-RESOLVED SIMULATION MODEL FOR PREDICTIONS OF MULTI-CYLINDER ENGINE INSTANTANEOUS SPEED AND TORQUE 893
- 12 Jasmin Luckin, Miroslav Grubišic
IMPACT OF HARDWARE FAULTS ON CAN BUS ON VEHICLE DISTRIBUTED ELECTRICAL SYSTEM 899

13	Zdravko Božickovic, Dragoslav Dobraš, Valentina Golubovic-Bugarski INFLUENTIAL FACTORS ON THE BRAKING FORCE INTENSITY DURING FORCE CONTROL ON A DEVICE WITH ROTARY ROLLERS	905
14	Drago Soldat, Robert Molnar, Marija Matotek INTEGRATION OF GEOGRAPHIC INFORMATION SYSTEM (GIS) AND LOGISTICS IN ORDER TO GENERATE VEHICLE ROUTES	911
15	Nenad Miljic, Slobodan Popovic, Marko Kitanovic, Predrag Mrdja, Mirosljub Tomic NEURAL NETWORKS MODELS USAGE IN METHODS FOR COMBUSTION PROCESS INFORMATION EXTRACTION IN IC ENGINES	917
16	Dobrivoje Ninkovic ON THE USE OF THE DISCHARGE COEFFICIENT CONCEPT IN THE IC ENGINE VALVE MASS FLOW RATE CALCULATIONS	923
17	Milanko Damjanovic, Sreten Simovic IMPACT OF CLEARANCE ON POWER TRANSMISSION DYNAMIC LOAD	937
18	Marko Kitanovic, Slobodan J. Popovic, Nenad Miljic, Predrag Mrdja, Mirosljub Tomic SIMULATION STUDY OF A TRANSIT BUS EQUIPPED WITH ANULTRACAPACITOR-BASED HYBRID SYSTEM	943
19	Jasna Glišovic, Jovanka Lukic, Danijela Miloradovic STABILITY ANALYSIS OF DISC BRAKE MODEL: A PARAMETRIC STUDY	949
20	Dragan Taranovic, Radivoje Pešic, Aleksandar Davinic, Saša Milojevic THERMODYNAMIC CHARACTERISTICS OF RECIPROCATING COMPRESSORS FOR MOTOR VEHICLES	955
21	Blažević Almir, Bibić Dževad, Filipović Ivan TURBOCHARGERS PERFORMANCE TESTING WITH SPECIAL EMPHASIS ON THE COMPRESSOR MAP	961
22	Rajko Radonjic, Dragoljub Radonjic, Aleksandra Jankovic VEHICLE DYNAMICS INVESTIGATION	969
23	Vladimir Pajkovic, Mirjana Grdinic AN ANALYSIS OF YOUNG DRIVER ACCIDENTS IN ROAD TRAFFIC USING IN DEPTH CRASH INVESTIGATION DATA	975

MECHATRONICS

1	Corina Daniela Cuntan, Ioan Baciuc, Cezara Rat A SELECTION AND DISPLAY SYSTEM FOR NUMERIC INFORMATION DEVELOPED IN LABVIEW	985
2	Vojkan Cvijanovic, Vladimir Kvirgic, Goran Ferenc	

	AN ANALYSIS OF CONTEMPORARY TECHNOLOGIES FOR THE SECURE USER TO USER EMAIL TRANSFERS	993
3	Mitar Jocanovic, Velibor Karanovic, Darko Knežević APPLICATION OF GEAR REDUCER OILS IN FOOD PROCESSING INDUSTRY	999
4	Remigiusz Labudzki APPLICATION THE MACHINE VISION TO PRODUCT PACKAGING	1005
5	Isak Karabegovic, Sanel Karabegovic, Ermin Husak, Safet Isic AUTOMATION OF CONVEYOR LINES IN THE MILK TREATMENT INDUSTRY	1011
6	Tihomir Latinovic, Mihailo Lazarevic, Sorin Deaconu, Gabor Sziebig FUZZY LOGIC COMBINED WITH NEURAL ALGORITHM TO CONTROL INDUSTRIAL ROBOT	1019
7	Sorinloan Deaconu, Razvan Deaconu, Tihomir Latinovic HIGH POWER STATIC CONVERTERS IN INDUSTRY APPLICATIONS	1025
8	Tanja Kerezovic, Gabor Sziebig, Bjørn Solvang, Tihomir Latinovic HUMAN SAFETY IN ROBOT APPLICATIONS – REVIEW OF SAFETY TREND	1031
9	Slaviša Galamic, Trygve Thomessen, Balazs Daniel INTRODUCTION TO A FORCE CONTROLLED BEER POURING ROBOT	1041
10	Mina Vaskovic, Marko Jurišević, Nenad Babajic, Milan Matijevic PIONEER 3-DX DISTANCE CONTROL USING DIFFERENT TYPE OF SENSORS	1049
11	Dragan Živanic, Anto Gajic, Jovan Vladic, Radomir Djokic, Zdravko Ristic PROPERTY OF PROGRESSIVE ZONING IN THE ORDER PICKING SYSTEMS	1053
12	Petar Mandic, Mihailo Lazarevic, Slavoljub Stojanovic, Milan Ristanovic REAL TIME CONTROL OF ROTARY INVERTED PENDULUM	1059
13	Audun Rønning Sanderud, Trygve Thomessen RELEASING THE SYNERGY OF HUMAN-ROBOT COLLABORATION – REDUNDANT ROBOTICS IN PRACTICE	1065
14	Nikola Malešević, Gabor Sziebig, Bjørn Solvang, Tihomir Latinovic SIMULATION OF ROBOTIC TASKS WITH VALIP SYSTEM – PRACTICAL APPLICATION	1071
15	Mihailo Lazarevic, Petar Mandic, Tihomir Latinovic, Trygve Thomessen SOME RESULTS OF CONTROL AND SIMULATION OF NEURO ARM ROBOT	1077
16	Isak Karabegovic, Edina Karabegovic, Mehmed Mahmic, Ermin Husak THE FUTURE AND STRATEGIC DEVELOPMENT OF SERVICE ROBOTS IN THE 21th CENTURY	1083

17	Ivan Ciric, Zarko Cojbašic, Vlastimir Nikolic, Predrag Živkovic, Dusan Petkovic, Mladen Tomic, Misa Tomic	THERMAL VISION INTEGRATION IN MOBILE ROBOT VISION SYSTEM	1091
18	Zoran Rajilic	TIME SERIES ANALYSIS USING MinLMaxL DIAGRAMS	1099
19	Rodoljub Vujanac, Radovan Slavkovic, Nenad Miloradovic, Mirko Blagojevic	VERTICAL RECIPROCATING CONVEYOR AS A PART OF FULLY AUTOMATED MULTI DEPTH PALLET RACK STORAGE SYSTEM	1105
20	Vasilije Vasic, Mihailo P. Lazarevic, Taško Maneski	ADAPTRONIC SYSTEM AND VIBRATION CONTROL WITH MR DAMPERS	1113

MAINTENANCE OF TECHNICAL SYSTEMS, OCCUPATIONAL SAFETY

1	Ninoslav Zuber, Rusmir Bajric	CHALLENGES OF GEAR FAULT DETECTION BASED ON VIBRATION SIGNAL PROCESSING TECHNIQUE	1121
2	Silvana Angelevska, Ivo Kuzmanov, Zore Angelevski, Vasko Stojanovski	MAINTANCE MANAGEMENT AND USING BENCHMARKING AS A TOOL IN THE FRAME OF WORLD CLASS INDUSTRIAL SYSTEM	1127
3	Dušan Djurovic, Miodrag Bulatovic	MAINTENANCE AND AVAILABILITY OF MACHINERY	1133
4	Tale Geramitchioski, Ljupco Trajcevski	MONITORING THE CONDITION OF THE MACHINERY IN A METAL SMELTER FENI KAVADARCI USING VIBRATION SIGNATURE	1139
5	Kazafer Becic, Veljko Vukovic, Safet Sinanovic	TECHNOLOGICAL PROCEDURE OF PROCESSING AND DYNAMIC BALANCING COLLECTOR OF TRACTION MOTORS TYPE 644-8 ISVK	1145
6	Vujadin Aleksic, Ljubica Milovic, Srdjan Bulatovic	TESTING OF METALS IN THE FUNCTION OF DETERMINING THE FAILURE OF TURBINE SHAFT – METHODOLOGICAL APPROACH	1153
7	Dragoljub Vujic	WIRELESS SENSOR NETWORKS IN AIRCRAFT DESIGN AND STRUCTURAL HEALTH MONITORING	1159
8	Adnan Ramakic, Zlatko Bundalo	DATA PROTECTION IN MICROCOMPUTER SYSTEMS AND NETWORKS	1165
9	Vladan Andonovic, Marija Ackovska, Neda Petroska Angelovska	RFID AS A MODERN BRAND PROTECTION TECHNOLOGY	1171
10	Nenad Miloradovic, Rodoljub Vujanac, Danijela Miloradovic, Blaža Stojanovic		

	USE OF WORKING PLATFORMS ON FORKLIFT TRUCKS	1177
11	Aleksandar Majstorovic THE MICROBIOLOGICAL ANALYSIS OF COMPRESSED MEDICAL AIR FROM BREATHING APPARATUS	1183
12	Ivo Kuzmanov, Silvana Angelevska, Zore Angelevski, Vasko Stojanovski EVALUATING THE INJURIES INTO BITOLA'S REGION IN 2012, REAL ENTERPRISE EXPERIENCE AND WAYS FOR IMPROVING THE SAFETY SYSTEMS INTO REAL ENTERPRISES	1189
13	Biljana Naumovska, Jasmina Chaloska, Ljuben Dudeski HUMAN VIBRATIONS EFFECTS, MEASUREMENT AND PROTECTION	1197
14	Boban Cvetanovic LEGISLATION AND STANDARDIZATION RELATED TO WHOLE BODY VIBRATION	1205
15	Petar S. Djekic, Anica Milosevic, Sladjana Nedeljkovic SAFETY AND HEALTH AT WORK IN THE PRODUCTION OF RUBBER CONVEYOR BELTS	1211
16	Biljana Vranješ STATISTICS METHODS IN THE ANALYSIS OF INJURIES AT WORK	1217
17	Mihajlo Ivanov, Jasmina Chaloska, Ljuben Dudeski THE ASSESSMENT OF RISK – BASE OF PREVENTIVE MEASURES LIKE PRIORITY IN THE SYSTEM OF SAFETY AT WORK	1223



RING-TYPE WATER SUPPLY NETWORKS

Kire Popovski¹, Stojance Nusev², Igor Andreevski³

Summary: *Standard calculation of water supply networks takes a lot of time and requires high accuracy while computer programmes for this purpose are very expensive. A computer program has been made to reduce the calculation time and to increase the accuracy of the calculation with no additional cost. The program is fully automatic and does not require previous experience and advanced computer knowledge to operate it. There are two types of water supply networks, branched and ring-type. Ring type consists of a series of closed loops (rings) surrounding the consumers and supply them with water through branches (sections). This type of water supply networks has an advantage over branched type because they do not require stopping of water in the entire network in a case of exclusion of certain parts of the network. When all input parameters are known, it is necessary to calculate the diameters of all sections and meet the required pressure drop in each of them.*

Keywords: *ring water supply networks.*

1. INTRODUCTION

According to hydraulic connections, there are two types of water supply networks, branched and looped (ring-type). Looped water supply network, Fig. 1, consists of a number of closed loops (rings) surrounding the consumers while supplying them with water through sections. This kind of network has advantage over branched type because there is no need to interrupt the supply to all network if and intervention is required only on one part of it. When calculation for looped type of water supply network is performed, two laws of hydraulics have to be satisfied:

- The sum of volume flows in every node must to be zero, that is the amount of water entering and leaving the node must be equal and
- At constant flow, the pressure difference between two cross-sections in the network is used to overcome the resistance and geodetic height between the cross-sections.

In order to explain the mathematical model, which used as a base for development of computer programme, an example shown in Figure 1 is used. Every

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branch is labeled with number and the corresponding volume flow (ex. 1-14 means branch 1, 14 l/s). Network is comprised of 4 loops also labeled with numbers in the middle. To run the computer programme properly, it has to be previously "filled" with input data (with known network data).

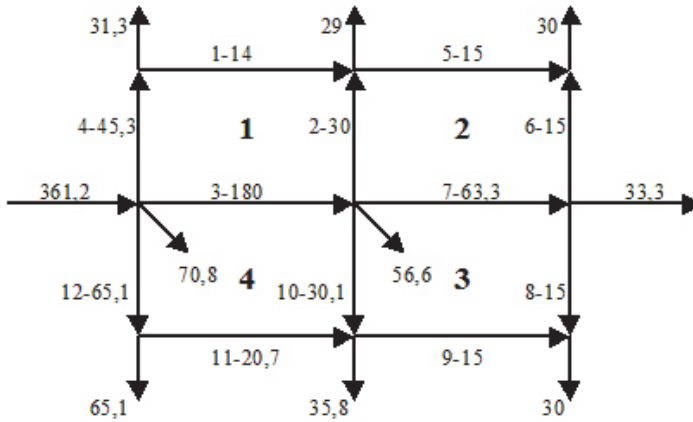


Fig. 1 Ring – type water supply network

Volume flow (inlet and outlet) and length of section represent input data for every node.

Total allowed pressure drop in the system is $\Sigma\Delta p=5000$ Pa, [1]. This value of pressure drop is enough to allow the complete calculation of the network to be with satisfying accuracy, but the computer programme itself allows the total pressure drop in some cases to reach values smaller than 100 Pa.

Number of loops: $j = 4$

Number of sections: $i = 12$

Friction coefficient of the pipe: $\lambda=0,018$

Density of water: $\rho=1000$ kg/m³

For calculation of the network parameters, relative direction of water movement in the loops have to be adopted. In this case, we adopt clockwise direction to be 'positive'.

With above shown input data it is necessary to calculate cross-sections of all section and to match the allowed pressure drop in each of them.

The calculation goes under the following order:

Pipe diameter,

$$D_i = 0,025 \cdot (\rho \cdot q_i)^{0,48} \text{ m.}$$

Calculated diameter is standardized onto the first greater standard size.

Recommended values for velocity of water in pipes are, $w=0,75 - 2$ m/s.

Hydraulic resistances,

$$S_i = \rho \cdot 0,01454 \cdot L_i \cdot D_i^{-5,33} \text{ Pa}\cdot\text{s}^2/\text{m}^6.$$

Energy losses due to friction (pressure drop),

$$\Delta p_i = S_i \cdot q_i^2 \text{ Pa.}$$

Correction of the flow in the loop,

$$\Delta q_j = -\frac{\sum \Delta p_i}{2 \cdot \sum S_i \cdot q_i} \text{ m}^3/\text{s.}$$

2. NUMERICAL EXAMPLE

Calculation is performed through iterations while the number of iterations is determined by the value of pressure drop, i.e. number of iterations must be sufficient to result in pressure drop equal or smaller than recommended value.

Table 1 Review of calculate water flow in each iteration

Section	<i>l</i> m	<i>q</i> l/s	<i>q</i> - 1 l/s	<i>q</i> - 2 l/s	<i>q</i> - 3 l/s	<i>d</i> mm	Δp Pa
1	880.000	14.000	9.410	9.241	9.233	100.0	234975
2	735.000	30.000	32.242	32.362	32.362	151.0	267734
3	880.000	180.000	185.000	185.469	185.445	313.9	212451
4	735.000	45.300	36.760	36.593	36.602	160.3	249003
5	880.000	15.000	14.280	14.281	14.241	100.0	559026
6	735.000	15.000	16.305	16.304	16.365	100.0	616599
7	880.000	63.300	64.744	63.719	63.708	211.1	208051
8	735.000	15.000	15.908	16.739	16.739	100.0	645149
9	880.000	15.000	14.485	15.035	15.035	100.0	623128
10	735.000	30.100	30.722	29.906	29.909	151.0	228694
11	880.000	20.700	18.623	18.291	18.275	125.0	280049
12	735.000	65.100	62.434	62.163	62.147	211.1	165357

Number of iteration depends on the accuracy determined in the computer programme. In this case, the accuracy is set to 0,11 l/s which means that the difference between calculated flow in the section from the previous iteration and currently calculated flow in the same section should not be greater than 0,1 l/s.

Accuracy of mathematical model and computer programme is proved by comparing with the same network calculated according to [1]. Comparison is presented on Table 2.

Table 2 Comparison of results

Section	Starting flow l/s	Calculated flow l/s	Calculated flow l/s according to [1]	<i>l</i> m	<i>d</i> mm	<i>d</i> mm according to [1]
1	14.000	9.233	9.470	880	100.0	150
2	30.000	32.362	32.500	735	151.0	200
3	180.000	185.445	190.480	880	313.9	400
4	45.300	36.602	40.770	735	160.3	200

5	15.000	14.241	12.970	880	100.0	150
6	15.000	16.365	17.030	735	100.0	150
7	63.300	63.708	67.580	880	211.1	300
8	15.000	16.739	17.250	735	100.0	150
9	15.000	15.035	12.750	880	100.0	150
10	30.100	29.909	33.800	735	151.0	200
11	20.700	18.275	14.750	880	125.0	150
12	65.100	62.147	59.150	735	211.1	250

3. NOMENCLATURE

d	diameter of the section,
H	geodetic height of node in the network,
l	length of section,
p	pressure in network,
q	volume flow of water in section,
w	velocity of water in section,
Δp	energy loss due to friction.

REFERENCES

- [1] Šašić, M. (1982). *Transport fluida u cevima*, Mašinski fakultet, Beograd, Srbija.
- [2] Stojanovski V., Popovski K. (2004). *Transportni sistemi i transport vo cevki*, Zbirka na rešeni i ispitni zadači, I del, Tehnički fakultet, Bitola, Makedonija.
- [3] Dymond J.H., Nieto de Castro C.A. (1996). *Transport properties of fluids: their correlation, prediction and estimation*, Cambridge University Press, UK.
- [4] Swamee P.K., Sharma K.A. (2008). *Design of water supply pipe networks*, Wiley-interscience.