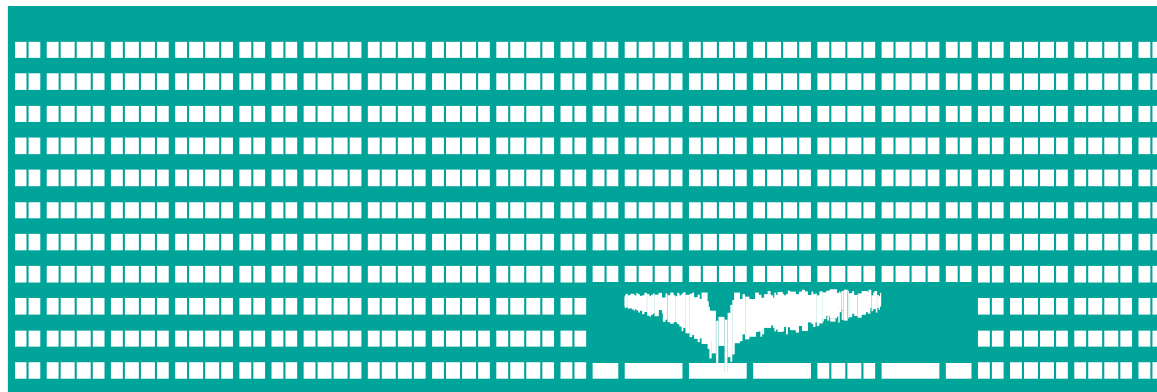**VŠB** TECHNICKÁ
UNIVERZITA
OSTRAVA

VSB TECHNICAL
UNIVERSITY
OF OSTRAVA

www.vsb.cz

R&D Activities

Research Group:
Applied Electronics and Electric Drives

Martin Kuchar, Ph.D.

Associate Professor, Deputy Head of Department

R&D Activities

Research Group: Applied Electronics and Electric Drives

Leader:	**Petr Palacky, Ph.D.**
	Professor, Head of Department
Academic staff members:	Martin Kuchar, Ph.D., Dagmar Juchelkova, Ph.D., Vaclav Sladecek, Ph.D., Martin Sobek, Ph.D., Libor Stepanec, Ph.D.
Ph.D. students:	Vojtech Sotola, David Bielesz, Richard Blaho, Stepan Kirschner, Marek Kubatko, Robert Kucera, Jan Milata, Kamal Hamani, Huu Chau Minh Nguyen

Main R&D areas:

- Development and implementation of new control methods of electric drives
- Modernization of electronic equipment in the area of industrial electronics
- Modernization and optimization of electric drives

R&D Activities
Research Group: Applied Electronics and Electric Drives

- **Sensorless AC Drives**
  - Methods based on electrical machine mathematical model
    - State space observers - Luenberger observer, Gopinath observer, Sliding mode observer, Kalman observer etc.
    - Model Reference Adaptive System - Rotor Flux MRAS, Current Based MRAS, Back Electromotive Force MRAS, X-MRAS, Q-MRAS etc.
  - Methods without knowledge of electrical machine mathematical model
    - Artificial intelligence based estimators, soft-computing approaches

- **Application of soft computing methods and artificial intelligence in electric drives**
  - Artificial neural networks, genetic algorithms, particle swarm optimization, cuckoo search algorithm etc.

- **Sensor Fault Tolerant Control of AC Drives**
  - Speed sensor failure, stator current sensors failure

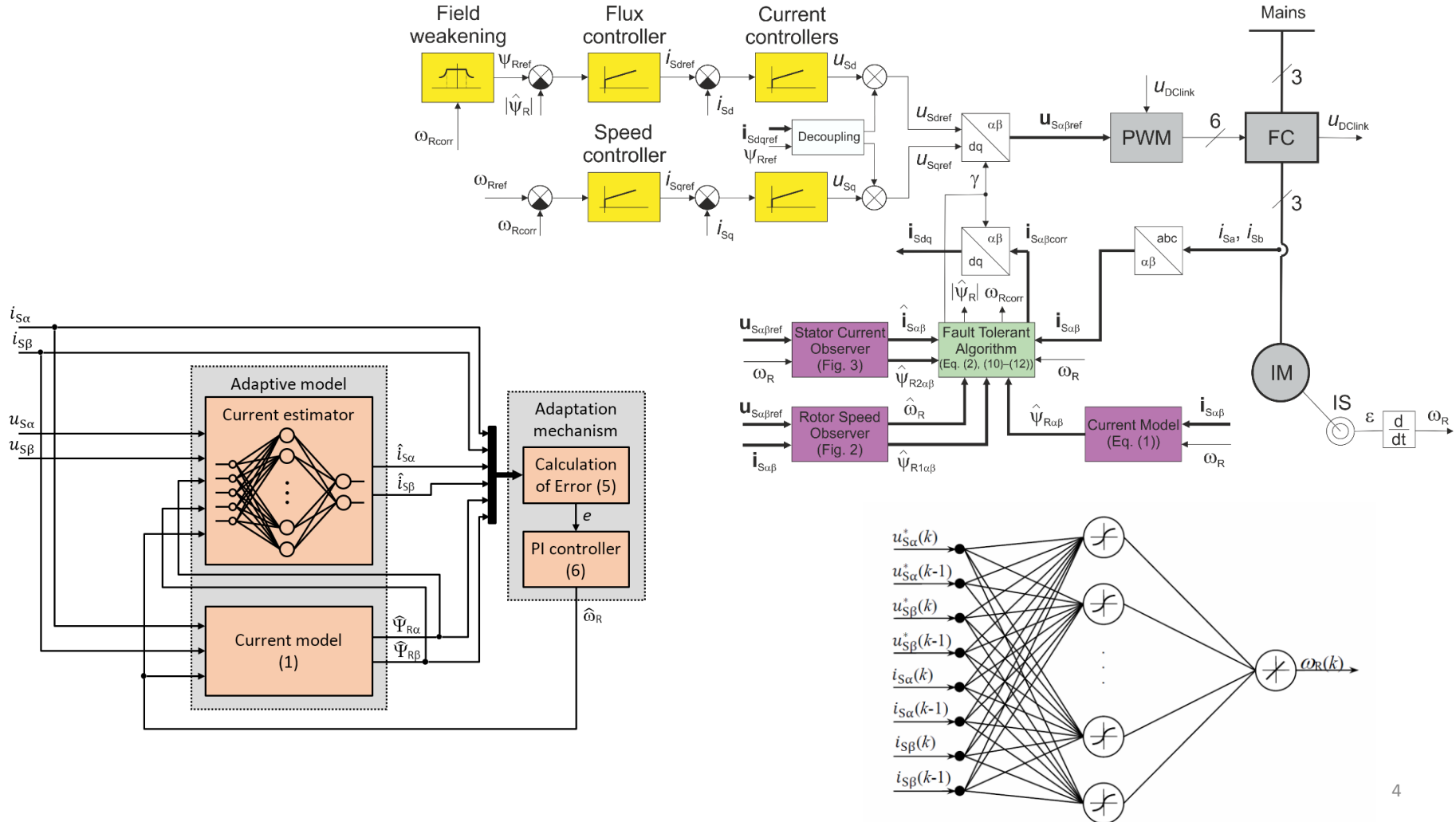- **Identification and adaptation of electric machine or observer parameters**

- **Predictive maintenance of induction motors**

- **HW and SW development for microcomputer control systems using DSC, MCU**

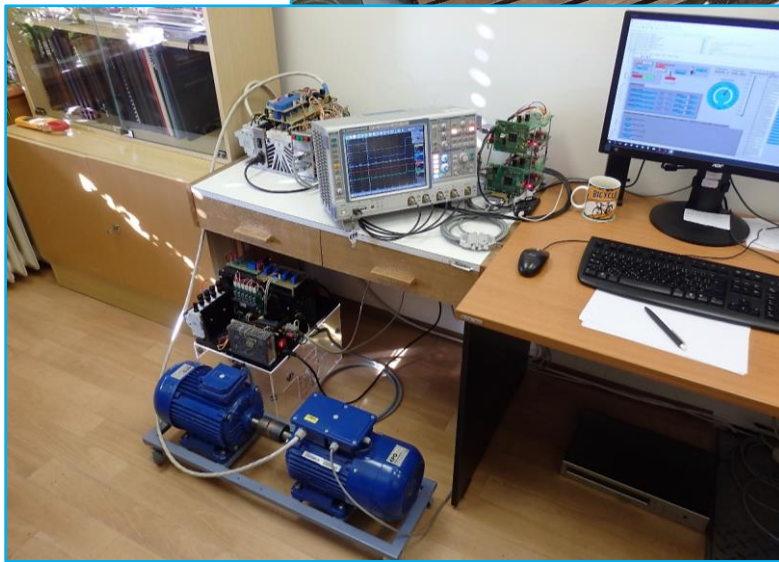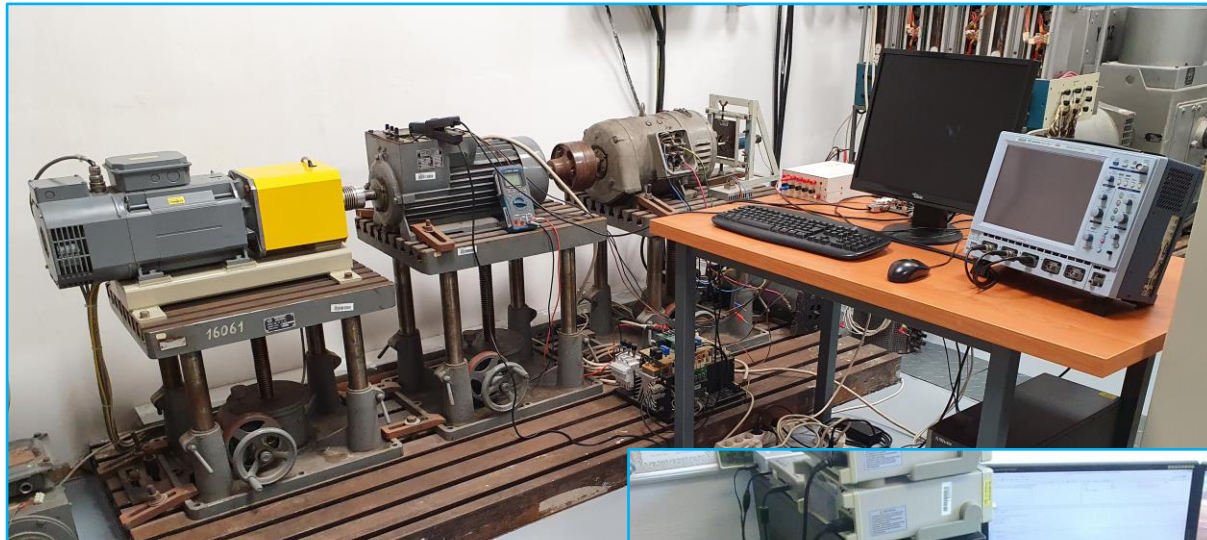- **Design and optimization of electric drives for industry**

R&D Activities
Research Group: Applied Electronics and Electric Drives

R&D Activities - Applied Electronics and Electric Drives
Sophisticated control methods development - Laboratory stands

R&D Activities - Applied Electronics and Electric Drives
HW design - TMS320F28379D-based control system

Core & Memory:
2 x C28x, 32-bit, RISC, 200 MHz, 800MIPS, FPU *(Floating Point Unit)*.
VCU-II (*Veterbi, Complex Math*) CRC
TMU (*Trigonometric Math Unit*)
2 x CLA (*Control Law accelerator*), 200 MHz

1MB Flash, 204KB SRAM,

A/D converter:
4 x 12/16-bit ADC (24/12 channels)

D/A converter:
3 x 12-bit DAC

PWM modulator:
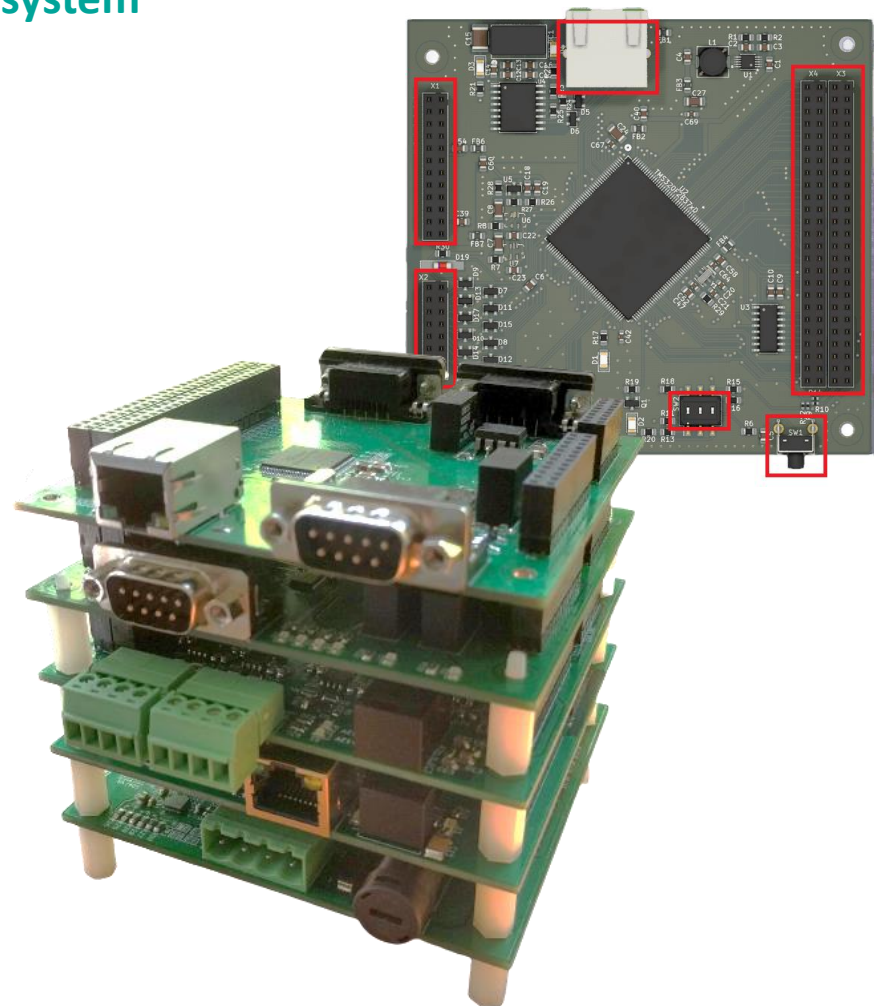1 x 24 channels ePWM modulator
1 x 16 channels HRePWM modulator

Quadrature decoder:
3 x eQEP modul for incremental encoder

Communication interfaces:
Support industrial communication standards with galvanic isolation such as UART/SCI, SPI, I2C and CAN.

R&D Activities - Applied Electronics and Electric Drives
HW design - NXP Kinetis MKV58FX-based control system

Core & Memory:
ARM Cortex M-7, 240 MHz, 1MB Flash, 256KB RAM,

A/D converter:
Internal 16bit ADC converter and 12bit HSADC,
27 channels

D/A converter:
8 channels 12 bit serial input DAC (through SPI)

PWM modulator:
16 channels FlexPWM/Motor Control modulators with
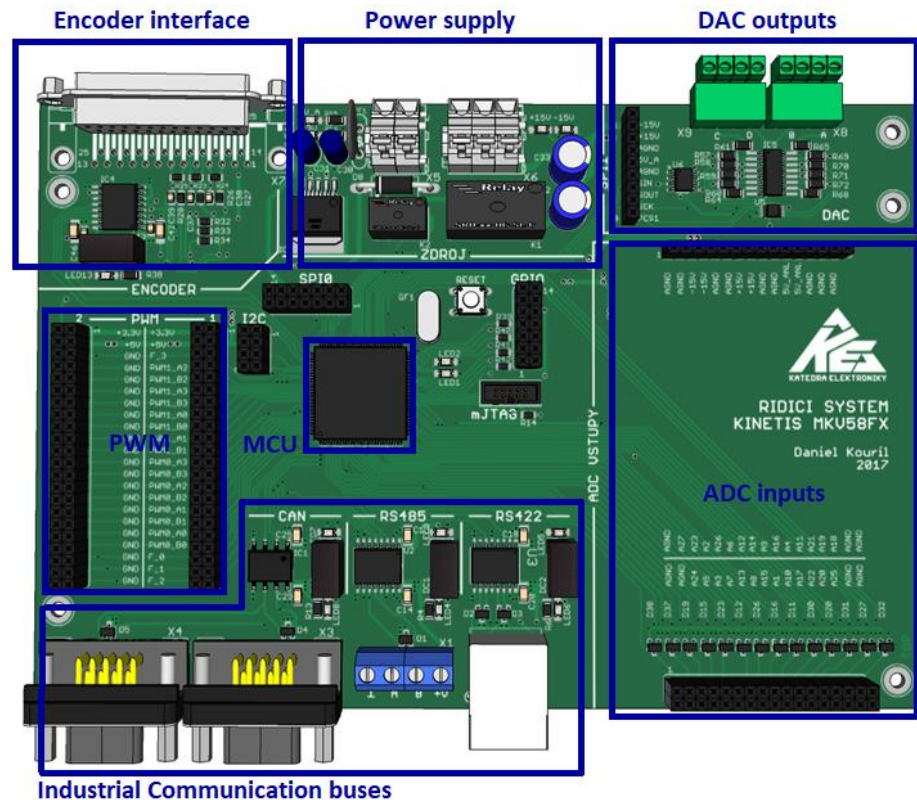Fault inputs

Quadrature decoder
3 outputs - revolution, position and difference position
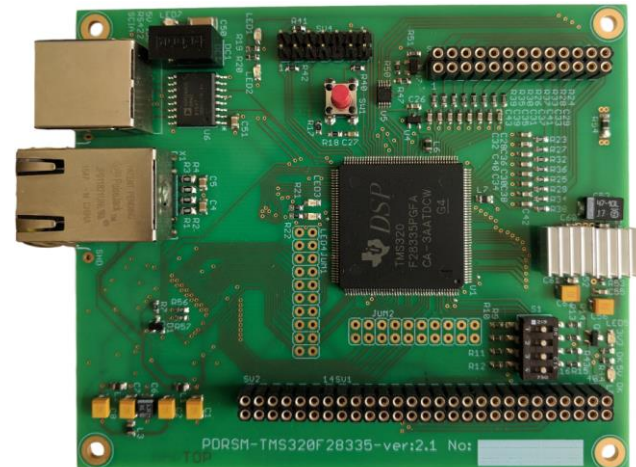counters
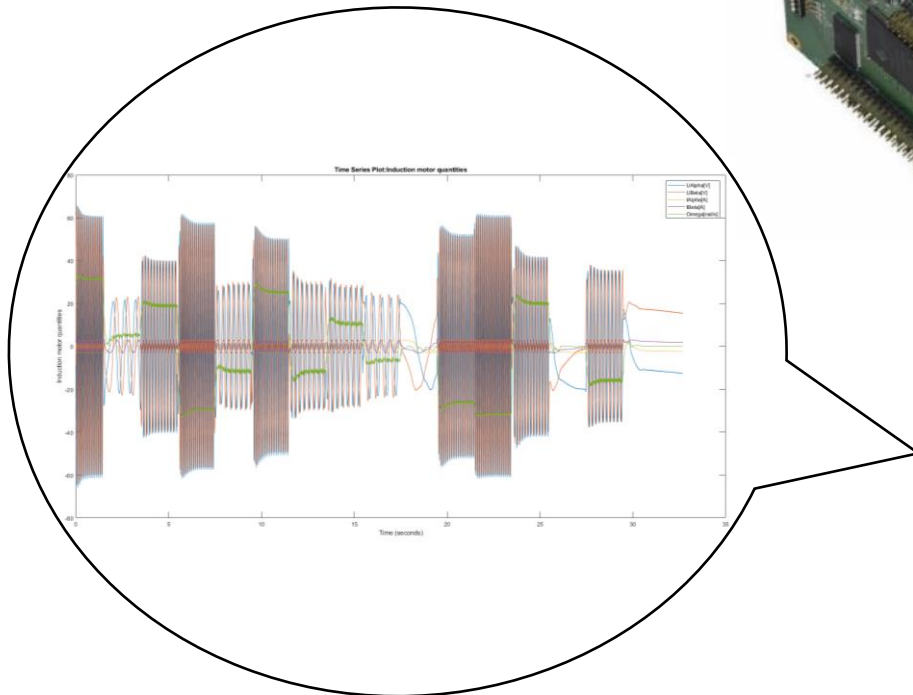
Communication interfaces:
Support industrial communication standards with galvanic
isolation such as UART/RS485, UART/RS422 and CAN.

Debug:
JTAG/cJTAG/SWD

R&D Activities - Applied Electronics and Electric Drives
HW design - TMS320F28335-based control system + data acquisition extension

R&D Activities - Applied Electronics and Electric Drives
Design and optimization of electrical drives for industry

Assembly line model

Small hydropower plant model

R&D Activities - Applied Electronics and Electric Drives
Important Projects

- E-Town - Development of super-light, long-range small electric vehicles for intergenerational, urban e-mobility concepts powered by smart infrastructure; Ministry of Education, Youth and Sports of the Czech Republic; No. LTE220001; 2021-2022.

- Research Platform focused on Industry 4.0 and Robotics in Ostrava agglomeration; Operational Programme Research, Development and Education; No. CZ.02.1.01/0.0/0.0/17_049/0008425; 2018-2022.

- Involvement of Czech research organizations in European Educational Research Association (EERA-CZ 2); Ministry of Education, Youth and Sports of the Czech Republic; No. LTI19002; 2019-2021.

- Centre for Intelligent Drives and Advanced Machines Control (CIDAM), Centre of Competence, Technology Agency of the Czech Republic; No. TE02000103; 2014-2019.

- IT4Innovations Centre of Excellence, Research Programme VP5, R&D for Innovations Operational Programme; No. CZ.1.05/1.1.00/02.0070; 2011-2014.

- Energy Units for Utilization of Non-Traditional Energy Sources (ENET), R&D for Innovations Operational Programme; No. CZ.1.07/2.3.00/20.0075; 2010-2014.

- HS430002 – Škoda Electric a.s.: Research of Algorithms for Regulating Drives with Asynchronous Motor without Speed Sensor, 2010.

An overview of the department's projects can be found at the following link:

https://www.fei.vsb.cz/430/en/research/projects/

R&D Activities - Applied Electronics and Electric Drives
Recent Important Publications

- Tran, C.D., Kuchar, M., Sobek, M., Sotola, V., Dinh, B.H. Sensor Fault Diagnosis Method Based on Rotor Slip Applied to Induction Motor Drive. *Sensors*, 2022, vol. 22, Article no. 8636. DOI: 10.3390/s22228636

- Khan, M., Raza Naqvi, S., Ullah, Z., Ali Ammar Taqvi, S., Nouman Aslam Khan, M., Farooq, W., Taqi Mehran, M., Juchelková, D., Štěpanec, L. Applications of machine learning in thermochemical conversion of biomass-A review. *Fuel*, 2022, vol. 332, Article no. 126055. DOI: 10.1016/j.fuel.2022.126055

- Kuchar, M., Palacky, P., Perdukova, D., Sobek. M. Compensation of Torque-Producing Stator Current Error for Vector-Controlled Induction Motor Drives. *Energies*, 2022, vol. 15, no. 3, article no. 815. DOI: 10.3390/en15030815

- Khan, A.A., Gul, J., Naqvi, S.R., Ali, I., Farooq, W., Liaqat, R., AlMohamadi, H., Štěpanec, L., Juchelková, D. Recent progress in microalgae-derived biochar for the treatment of textile industry wastewater. *Chemosphere*, 2022, vol. 306, Article no. 135565. DOI: 10.1016/j.chemosphere.2022.135565

- Tran, C.D, Palacky, P., Kuchar, M., Brandstetter, P., Dinh, B.H. Current and Speed Sensor Fault Diagnosis Method Applied to Induction Motor Drive. *IEEE Access*, 2021, vol. 9, pp. 38660-38672. DOI: 10.1109/ACCESS.2021.3064016

- Kuchar, M., Palacky, P., Simonik, P., Strossa, J. Self-Tuning Observer for Sensor Fault-Tolerant Control of Induction Motor Drive. *Energies*, 2021, vol. 14, no. 9., article no. 2564. DOI: 10.3390/en14092564

An overview of the department's publications can be found at the following link:

https://www.fei.vsb.cz/430/en/research/publications/

Thank you for your attention

Martin Kuchar, Ph.D.

martin.kuchar@vsb.cz

www.vsb.cz