**EE 535 Control of Electric Machine Drives**

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| **Lecture Schedule** | | See Time Table | **Course Type, Semester** | Graduate, Fall 2018 | | | |
| **Credit Hours** | | 3 | **Pre-requisite** | * Power Electronics (Undergraduate) EE452 * Control Systems (Undergraduate) EE343 | | | |
| **Instructor(s)** | | Dr. Syed Abdul Rahman Kashif | **Contact** | [abdulrahman@uet.edu.pk](mailto:abdulrahman@uet.edu.pk) | | | |
| **Office** | | Ground Floor, EED | **Office Hours** | Monday 12:00 to 1:00 PM  Tuesday 12:00 to 1:00 PM | | | |
| **Teaching Assistant(s)** | | None | **Lab Schedule** | Not Applicable | | | |
| **Course Description** | | Electrical machines drives will be discussed in detail in terms of performance, design, control and implementation. Control of DC motors, power electronic converters for drives, dynamic model of AC machines and their scalar and vector control will be taught with special concentration on three phase induction machines. | | | | | |
| **Measurable Learning Outcomes** | **CLOs** | **Description** | | | **Domain** | **Taxonomy Level** | **PLOs, Levels** |
| CLO1 | Use basic principles to model DC machines, AC machines and power electronics converters for electrical machine drives. | | | Cognitive | 3 | PLO1  Medium |
| CLO2 | Formulate advanced control algorithms for induction motor control. | | | Cognitive | 6 | PLO4  High |
| CLO3 | Design and control of DC-DC converter with feedback and inverters for DC motor control. | | | Cognitive | 6 | PLO3  High |
| CLO4 | Integrate simulation tools to control power electronic converters for a specific machine. | | | Psychomotor | 4 | PLO5  Medium |
| CLO5 | Recreate and present the results of a research paper. | | | Psychomotor | 2 | PLO12  Low |
| **Textbooks** | | **REQUIRED** :   * Modern Power Electronics and AC Drives by Bimal K. Bose, 2004. * Electrical Machine Drives by Krishnan * Fundamental of Power Electronics by Ericson   **Supplementary Reading:**   * Power Converters and AC Electrical Drives with Linear Neural Networks by Maurizio Cirrincione, Marcello Pucci and Gianpaolo Vitale, CRC Press 2013 * Research Papers and Simulink Help for Electrical Drives | | | | | |
| **Grading Policy** | | Class Participation (Not Attendance) -  Quizzes/Research Paper Presentations CLO1-CLO7  Mid Term CLO1-CLO3  Final Term CLO3-CLO7 | | | | | |

**Lecture Plan**

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| **Week** | **Topics** | **Recommended Readings & CLOs** |
| 1 | **Modeling of DC Machines**  Introduction of DC machines, detailed modeling of a DC machine, transfer function and state space model, speed control of DC machines | Krishnan: Chapter 4  & Notes  (CLO1) |
| 2 | **Power Electronic Converters**  AC to DC Converters, DC to DC converters, four quadrant operation using converter, Model of converters used for machines control | Krishnan: Chapter 3  Ericson: Chapter 6  (CLO3) |
| 3 to 5 | **Control Design for DC Machines**  Converter circuits, converter transfer functions, controller design, filter design, simulation in Matlab | Ericson: Chapter 7-10  (CLO3) |
| 6 | **Basic Transformations**  Concept of different frame of references, conversion among different frames, Clark and Plank’s Transformations, concept of space vectors, Transformations in Simulink | B.K. Bose: Chapter 2  (CLO2) |
| 7 | **Three Phase Induction Motor**  Steady state model, torque speed characteristics, voltage control, frequency control, V/f control, rotor resistance control, Introduction to Power Inverters (180 degree inverter) | B.K. Bose: Chapter 2  (CLO2) |
| 8 | **Dynamic Model of a Three Phase Induction Machine**  Detailed modeling of a three phase induction machine in different frame of references and simulation in Simulink | B.K. Bose: Chapter 2  (CLO1 & CLO2) |
| 9 | **Space Vector Pulse width Modulation**  Inverter operation, space vector concept, calculation of duty cycles, implementation of space vector PWM for inverter control | B.K. Bose: Chapter 5  & Notes  (CLO3) |
| 10 | **State Space Model of a Three Phase Induction Machine**  State Space representation in different frames and derivation of different parameters for motor control. | B.K. Bose: Chapter 08  & Notes  (CLO2 & CLO3) |
| 11 & 12 | **Vector Control of IM**  Detailed derivation, design of controller, implementation on Simulink | B.K. Bose: Chapter 08  & Notes  (CLO2 & CLO4) |
| 13 | **Direct Torque Control**  Concept of direct torque control, implementation procedure, implementation using SVPWM, Hysterisis Control. | B.K. Bose: Chapter 08  & Notes  (CLO2 & CLO4) |
| 14 | **Sensorless Control of IM**  Speed estimation methods, estimation of flux, estimation of torque, effect of parametric variations, different algorithms for sensor-less control, implementation of sensor-less control in Simulink | B.K. Bose: Chapter 08  & Notes  (CLO2, CLO4, CLO5) |
| 15 & 16 | **Fuzzy Logic Control**  Basics of fuzzy logic, Development of a fuzzy logic controller, Control of a DC motor using fuzzy logic control, Implementation in Matlab/Simulink | B.K. Bose: Chapter 11  (CLO2, CLO4, CLO5) |