Approved in 44th BoA Meeting (24-11-2021)

Course number	**:** ET 503
Course Name	**:** Electrical Machine and Drives in Electric Transportation
Credit Distribution	**:** 3-0-0-3
Intended for	**:** UG/PG
Prerequisite	**:** Electromechanics (EE 201), Control System (EE301) and Power Electronics (EE 309)
Mutual Exclusion	**:** Nill

---

1. **Preamble:** Electrical machine and Drives is core course for Electric Transportation program. Since, speed control of electrical machines is the main objective. Therefore, this course deals with the fundamental concept of electric drives system which is supported by modelling and control of important electrical motors for Electric Transportation applications.

2. **Course Modules with quantitative lecture hours:**

Unit/Topic 1: Introduction to Electric Transportation (5 Hours)

Example of EVs; State of the art in Electric Vehicle Technology, Overview of EV technologies, Fuel Cell Electric Vehicles, Hybrid Electric Vehicles (HEVs), Vehicle Dynamics and Drive cycle, Introduction to Railway Systems

Unit/Topic 2: Fundamentals of Electric Drive control (12 hours)

Control Block diagram, Reference frame Theory, dq-reference frame, PI- controllers Design, Hysteresis controller

Control Methods: Field oriented control, Direct torque control, Sensor less control, Model Reference Adaptive Control (MRAC) Approach, Sliding mode control

DC machine Drive: Closed loop Speed Control of DC Motor Through armature voltage control and field control, Regenerative Braking

Control of motors in the EV: Multi Wheel Drive (MWD) or All Wheel Drive (AWD) systems, Torque vectoring etc.

Unit/Topic 3: Induction Motor Drives (10 hours)

Induction Machines: Squirrel Cage Induction Machine and Slip Ring Induction Machines αβ and dq- modeling of Induction Machines, Inverters for Induction Motors, PWM Switching Inverters, Soft-Switching Inverters

Induction Motor Control: Voltage by Frequency Control, Field-Oriented Control, Direct Torque Control,

Design Criteria of Induction Motor Drives for EVs, Design Example of Induction Motor Drives for EVs, Application Examples of Induction Motor Drives in EVs and Railways

Unit/Topic 4: Permanent Magnet Brushless Motor Drives (11 hours)

PM Materials,

PM Brushless Machines: Structure of PM Brushless Machines, Principle of PM Brushless

Machines, Modeling of PM Brushless Machines, Inverters for PM Brushless Motors, Inverter Requirements, Switching Schemes for Brushless AC Operation, Switching Schemes for Brushless DC Operation

PM Brushless Motor Control: PM Synchronous Motor Control, PM Brushless DC Motor Control

Design Criteria of PM Brushless Motor Drives for EVs: Design Examples of PM Brushless Motor Drives for EVs, Planetary-Geared PM Synchronous Motor Drive, Outer-Rotor PM Brushless DC Motor Drive, Application Examples of PM Brushless Motor Drives in EVs and Railways

Unit/Topic 5: Introduction to Special Machines (4 hours)

Switched Reluctance machine (SRM), Synchronous Reluctance Machine (SyRM) etc.

Laboratory/practical/tutorial Modules: Nil

3. Text books:

1. K. T. CHAU , "Electric Vehicle Machines and Drives: Design, Analysis and Application", Wiley-IEEE Press, 2015.
2. Morris Brenna, Federica Foiadelli, Dario Zaninelli , "Electrical Railway Transportation Systems" Wiley-IEEE Press, 2018.

4. References:

1. Ned Mohan, Siddharth Raju , "Analysis and Control of Electric Drives: Simulations and Laboratory Implementation" Aug. 2020
2. John G. Hayes, G. Abas Goodarzi , "Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles
3. W. Leonhard, "Control of Electric Drives" 2001.
4. P. Vas, Sensorless Vector and Direct Torque Control, Oxford Science Publications
5. Boldea, S. A. Nasar, "Electric Drives ", Second Ed. CRC Press Taylor & Francis Group 2006.
6. Bose B.K., "Power Electronics and Variable Frequency Drives – Technology and Applications", IEEE Press, Standard Publisher Distributors. 2001
7. Rashid M., "Power Electronics- Circuits, Devices and Applications", 3rd Ed., Pearson Education.
8. Krause, P. C., Wasynczuk, O., Sudhoff, S. D., "Analysis of Electric Machinery and Drive Systems", New York, Wiley-Interscience.
9. S. K. Pillai, A First Course on Electrical Drives, New Age International Pvt. Ltd.
10. R. Krishnan, Electric Motor Drives: Modeling, Analysis, and Control, Prentice Hall, 2001.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		EE508, EE604, EE528	8 hours	20%

6. Justification of new course proposal if cumulative similarity content is >30%: