**Approved in 40th BoA Meeting (11-05-2021)**

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| **Course Number** | : EE528 |
| **Course Name** | : Modelling and Analysis of Electrical Machines |
| **Credits** | : 2-0-2-3 (L-T-P-C) |
| **Prerequisites** | :EE 201 and EE201P - Electromechanics Theory and Laboratory/ Instructor Consent |
| **Intended for** | : BTech/M.Tech./MS/PhD |
| **Distribution** | : Core course for M. Tech. in Power Electronics and Drives, Elective forBTech, MTech, MS, PhD |
| **Semester** | : Odd |

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## 1. Course Preamble:

This is a fundamental modelling and analysis course for electrical machines. This course will focus on design-oriented analysis of conventional and advanced electrical machines. Analytical concepts discussed in the course are intended to strengthen thefundamental understanding of electromechanical systems, and also to provide a basic framework for control of electric drives. This course will be helpful for students interested in doing projects in this field. It is recommended that the students opting for this course should have the basic knowledge of Electromechanics.

## 2. Course Modules with quantitative lecture hours:

**Module1: Basic Principles of Electric Machine Analysis (4 hours)**

1. Review on basic magnetic circuits and electromagnets including analysis of magnetic circuits with airgap and permanent magnets.
2. Principle of Electromagnetic Energy Conversion
3. Basic Two pole DC Machine – primitive 2 axis machine -Voltage and Current relationship – Torque equation

**Module2: DC Machine Modeling (5 hours)**

4. Mathematical modeling of D.C. Machine (Separately Excited, shunt and series type)
5. Linearization of machine equations and state space modeling of the machine

**Module3: Induction Machine Modeling (9 hours)**

6. Distributed Winding in AC Machinery, winding function, air gap mmf, rotating mmf. Calculation of self and mutual inductances
7. Reference frame theory, stator and rotor voltage equations and torque equation in different reference frames, Linearized machine equations and Eigenvalue analysis, Derivation of model for steady-state analysis

8. Derivation of induction motor model in rotor fluxand stator flux oriented reference frame

**Module4: Synchronous Machine Modeling (4 hours)**

9. Voltage and torque equations of salient pole synchronous machine including damper winding in stator and rotor reference frames
10. Derivation of steady state model

**Module5: Permanent Magnet Machine Modeling (6 hours)**

11. Modeling of sine-wave and square-wave machines
12. Voltage and torque equations of surface-mounted permanent magnet machine in stator and rotor reference frames
13. Derivation of steady state model

**Modeling and Simulation Lab. Sessions:**

- Introduction to software's
- Mathematical modeling of simple circuits & systems
- Mathematical modeling of D.C. machines
- Reference frame theory
- Induction machine modelling in different reference frames including saturation effects
- Induction machine modelling for steady-state analysis
- Synchronous machine modelling in different reference frames including saturation effects
- Synchronous machine modelling for steady-state analysis
- Permanent magnet synchronous machine modelling
- Brushless DC machine modelling

**3. Textbooks**


1. Paul C. Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electric Machinery and Drive Systems" John Wiley and Sons, 2$^{nd}$Edition, 2006.
2. CheeMunOng, Dynamic Simulation of Electric Machinery, Prentice Hall, 1997 (https://in.mathworks.com/matlabcentral/fileexchange/9941-dynamic-simulations-of-electric-machinery-using-matlab-simulink)

3. R Krishnan, “Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press; 2009.

**4. References**

1. NPTEL Videos: Advanced Electric Drives by Prof. S P Das(https://nptel.ac.in/courses/108/104/108104011/#)
2. NPTEL Videos: Modelling and Analysis of Electric Machines, by Prof. K. Vasudevan(https://nptel.ac.in/courses/108/106/108106023/)
3. Bimbhra P.S., “Generalized Circuit Theory of Electrical Machines”, Khanna Publishers Limited, 5th Edition, New Delhi, 2000.
4. B. K. Bose, “Modern Power Electronics and AC Drives”, PearsonEducation, 2015
5. R Krishnan, “Electric Motor Drives – Modelling, Analysis and Control”, Pearson Education, 2015.
6. P.Vas, Vector Control of A.C. Machines, Clarendon Press, Oxford 1990.