

Electric Drives
(Professional Elective - III)

Prerequisite: Electrical Machines, Control Systems and Power Electronics.

Course Objectives:

1. To introduce the drive system and operating modes of drive and its characteristics.
2. To understand Speed - Torque characteristics of different motor drives by various power converter.
3. To analyse the machine behavior during motoring and braking operations.
4. To identify proper control techniques as per the load requirement.
5. To differentiate DC and AC drives suitable for an application.

UNIT - I (~ 10 Lecture Hours)

Introduction:

Electrical drives - Advantages - Parts of electrical drives - Choice of drive - Status of DC and AC drives.

Dynamics of Electrical drives:

Fundamental torque equations - Speed torque conventions and Multi-quadrant operation- Equivalent Values of drive parameters - Components of load torque- Nature and classification of load torques - Time and energy loss during transient period - steady state stability and load equalisation

Control of drives:

Modes of operation - Speed control and drive classification - Closed loop control of drives.

Selection of motor power rating:

Thermal model of motor for heating and cooling- classes of motor duty -

Determination of motor rating.

UNIT - II (~ 12 Lecture Hours)

Control of DC motors by Single phase Semi and fully controlled converters:

Single phase semi and fully controlled converter fed DC separately excited and series motors- Continuous current operation- Speed and torque expressions and characteristics- Related problems.

Control of DC motors by Three phase Semi and fully controlled converters:

Three phase semi and fully controlled converter fed DC separately excited and series motors- Continuous current operation - Speed and torque expressions and characteristics- Related problems.

Four Quadrant operation of DC drives: Motoring operation, Electric Braking- Plugging, Dynamic, regenerative braking operation, Four quadrant operation of DC motors by dual converters - Closed loop operation of DC motor(Block diagram only).

Control of DC motors By Choppers:

Single, double and four quadrant Chopper fed DC Separately excited and series motors- Problems.

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UNIT - III (~ 10 Lecture Hours)

Control of Induction Motor Through Stator Voltage And Stator Frequency: Variable voltage characteristics-Control of Induction Motor by Ac Voltage Controllers - Waveforms - speed torque characteristics.

Variable frequency characteristics-Variable frequency control of induction motor by voltage source and current source inverter and cyclo converters-PWM control - Comparison of VSI and CSI operations - Speed torque characteristics - Numerical problems- Closed loop operation. (Block Diagram Only)

Rotor Side Control of Induction Motor: Static rotor resistance control - Slip power recovery - Static Scherbius drive - Static Kramer Drive - their performance and speed torque characteristics - advantages, applications, Numerical problems.

UNIT - IV (~ 8 Lecture Hours)

Control of Synchronous Motors:

Separate control and self control of synchronous motors - operation of self controlled synchronous motors by VSI and CSI. Load commutated CSI fed Synchronous motor- Operation - Waveforms - speed torque characteristic - Applications - Advantages - Closed loop control operation of synchronous motor drives (Block diagram only) - Variable frequency control - Cyclo converter, PWM based VSI and CSI control.

UNIT -V (~6 Lecture Hours)

Stepper motor and Switched reluctance motor (SRM) drives:

Variable reluctance -Permanent magnet- Features of stepper motor- Torque vs stepping rate characteristics - Drive circuits for stepper motors. SRM operation and control - Converter circuits - Modes of operation.

Text Books:

1. Gopal K Dubey, "Fundamentals of Electric Drives", Narosa Publications, 2019.
2. Vedam Subramanyam, "Electric Drives, Concepts and Applications", McGraw Hill Publications, 2011.
3. S.K. Pillai, "Basics of Electric Drives", 4th Edition, New Academic Science 2014.

Reference Books:

1. S K Pillai, "Analysis of Thyristor Power-conditioned motors", University Press, 2005.
2. B. K. Bose, "Modern Power Electronics, and AC Drives", Pearson 2015.
3. R. Krishnan, "Electric motor drives - modeling, Analysis and control", Pearson, 2015.
4. P.V.Rao, "Power Semiconductor Drives", B.S.Publications, 2008.

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Course Outcomes:

After the completion of the course, the students will be able to,

1. Identify the advantages of drive control over conventional control techniques.
2. Interpret the basic drive system and its performance.
3. Classify the drives for different types of loads.
4. Distinguish the motor behavior during motoring and braking modes.
5. Compare the speed control of Induction Motor from stator side and rotor side and identify their merits and de-merits.
6. Explain the performance of the drive during closed loop operation.

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