

## ELECTRICAL & ELECTRONICS ENGINEERING Syllabus

### Module 1

Principle of Operation of three phase alternators, Constructional features, Types of Armature Windings(detailed winding diagram not required), EMF equation, Numerical Problems.

Harmonics-causes, suppression, Rating of alternators, Parameters of armature winding, Armature reaction, Equivalent Circuit, Phasor Diagram, Load characteristics, Power Flow Equations.

### Module 2

Voltage regulation of three phase Alternators-Direct loading, EMF Method, MMF Method, Potier Method,ASA Method -Numerical Problems.

Blondel's two reaction theory, Phasor Diagram under lagging power factor, Determination of  $X_d$  and  $X_q$  by slip test, Power developed by a Salient pole machine, Numerical Problems.

Parallel Operation of Alternators- Necessary Conditions, Synchronisation- Synchronising current, Power and Torque, Effect of reactance, Numerical Problems, Methods of Synchronisation.

### Module 3

Principle of Synchronous Motor, Equivalent circuit, Phasor diagrams, Power flow diagram and equations, Losses and efficiency -Numerical Problems, Power-angle Characteristics, V Curve and Inverted V Curves.

Three phase Induction motor – Constructional features, Expressions for Power and Torque-Torque- Slip characteristics, Phasor diagram, Equivalent Circuit of Induction motor- Tests on Induction motors for determination of equivalent circuit-Numerical Problems.

### Module 4

Performance of three phase Induction motors using Circle diagram, Numerical Problems. Cogging and Crawling in cage motors, Double cage Induction motor-Torque-Slip Characteristics.

Starting of Induction motors – Types of Starters – DOL starter, Autotransformer Starter, Star-Delta starter, Rotor Resistance Starter-Numerical Problems.

Braking of Induction motors – Plugging, Dynamic braking, Regenerative braking, Speed control – Stator Voltage control, V/f control, Rotor Resistance Control.

### Module 5

Induction generator – Principle of operation, Grid Connected and Self Excited Operation of Induction Generators, Torque-Slip Characteristics of an Induction machine.

Single phase Induction motors-Double field revolving theory, Equivalent Circuit, Torque-Slip Characteristics, Types of Single Phase Induction motor, Applications.

Selection of AC motors for different applications.

### Text Books

1. Bimbra P S, Electric Machines, Khanna Publishers, 2<sup>nd</sup> edition, 2017.
2. Kothari D. P., Nagrath I. J., Electric Machines, Tata McGraw Hill, 5<sup>th</sup> edition, 2017.
3. Say M G, The Performance and Design of AC Machines, CBS Publishers, New Delhi, 3<sup>rd</sup> edition, 2002.
4. Alexander S Langsdorf, "Theory of Alternating Current Machinery", Tata McGraw Hill, 2<sup>nd</sup> revised edition, 2001.

### Reference Books

1. Deshpande M. V., Electrical Machines, Prentice Hall India, New Delhi, Eastern Economy Edition, 2011.
2. Gupta B R, Vandana Singhal, "Fundamentals of Electric Machines", New Age International, 2010.
3. Ashfaq Husain, Haroon Ashfaq, Electric Machines, Dhanpat Rai and Co., 3<sup>rd</sup> edition, 2002.
4. Gupta J B, "Theory and Performance of Electrical Machines", S K Kataria & Sons, 14<sup>th</sup> edition, 2013.

### Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
<b>1</b>	<b>Basics of Alternators (10 hours)</b>	
1.1	Principle of operation and classification of alternators, Synchronous speed.	2
1.2	Construction of synchronous machines. Salient and Cylindrical types, Turbogenerators. Stationary and Rotating armature types.	1
1.3	Armature windings-Types.: Single layer, Double layer, Full pitched winding, Short pitched winding, Concentrated and Distributed winding	1
1.4	EMF Equation, Pitch factor and Distribution factor, Numerical problems	3
1.5	Harmonics in Alternators: Space and slot harmonics, Suppression, Effect of pitch factor on harmonics.	1
1.6	Armature Reaction, Equivalent Circuit and Phasor Diagrams, Power Flow Equations	2
<b>2</b>	<b>Voltage Regulation and Synchronisation of Alternators (10 hours)</b>	
2.1	Voltage Regulation of Alternators: EMF, MMF, Potier and ASA Method.	4
2.2	Blondel's Two Reaction Theory, Phasor Diagram under lagging power	3

	factor based on two reaction theory, Slip Test	
2.3	Parallel Operation of Alternators, Necessity of Parallel Operation. Advantages.	1
2.4	Synchronisation of Alternators: Dark Lamp and Bright Lamp Method.	2
<b>3</b>	<b>Three Phase Synchronous and Induction Motors (10 hours)</b>	
3.1	Synchronous Motors-Principle, Equivalent Circuit, Phasor Diagrams, Power Flow Diagram, Power and Torque Equations, Numerical Problems	3
3.2	Effects of excitation on armature current and power factor- V and Inverted V Curves, advantages, disadvantages and applications of Synchronous motors.	1
3.3	Three phase Induction Motors-Principle, Constructional details, Slip ring and Cage types.	1
3.4	Slip, frequency and rotor current, Expression for torque and Power- Starting torque, Full load and Pull out torque, Torque- Slip characteristics, Phasor diagram.	3
3.5	Tests on Induction motors for determination of Equivalent circuit, Equivalent Circuit of Induction motor-Numerical Problems.	2
<b>4</b>	<b>Three Phase Induction Motors Contd. (8 hours)</b>	
4.1	Circle Diagram, Numerical Problems.	3
4.2	Cogging, Crawling—remedial measures, Double Cage Induction Motor-Principle.	1
4.3	Starters for three phase Induction Motors: DOL, Autotransformer, Star Delta and Rotor Resistance Starters.	2
4.4	Speed Control in Induction Motors	1
4.5	Braking in Induction Motors	1
<b>5</b>	<b>Induction Generators and Single Phase Induction Motors (7 hours)</b>	
5.1	Induction Generators: Grid Connected and Self Excited types.	1
5.2	Single phase induction motors-principle, Double field revolving theory, Torque-Slip characteristics, Applications	2
5.3	Types-Split phase, Capacitor Start, Capacitor Start and Run types, Shaded pole motor, Shaded Pole Motor-Principle of operation and applications.	3
5.4	Selection of AC motors for different Applications.	1