EE2302 - ELECTRICAL MACHINES II

1. **SYNCHRONOUS GENERATOR** **9**
   Constructional details – Types of rotors – emf equation – Synchronous reactance – Armature reaction – Voltage regulation – EMF, MMF, ZPF and A.S.A methods – Synchronizing and parallel operation – Synchronizing torque - Change of excitation and mechanical input – Two reaction theory – Determination of direct and quadrature axis synchronous reactance using slip test – Operating characteristics - Capability curves.

2. **SYNCHRONOUS MOTOR** **8**
   Principle of operation – Torque equation – Operation on infinite bus bars - V-curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power developed.

3. **THREE PHASE INDUCTION MOTOR** **12**
   Constructional details – Types of rotors – Principle of operation – Slip – Equivalent circuit – Slip-torque characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of no load losses – Double cage rotors – Induction generator – Synchronous induction motor.

4. **STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR** **7**
   Need for starting – Types of starters – Rotor resistance, Autotransformer and Star-delta starters – Speed control – Change of voltage, torque, number of poles and slip – Cascaded connection – Slip power recovery scheme.

5. **SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES** **9**
   Constructional details of single phase induction motor – Double revolving field theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors - Shaded pole induction motor - Linear reluctance motor - Repulsion motor - Hysteresis motor - AC series motor.

L -45, T – 15: TOTAL 60

TEXT BOOKS

1. D.P. Kothari and I.J. Nagrath, ‘Electric Machines’, Tata McGraw Hill Publishing Company Ltd, 2002.
2. P.S. Bhimbhra, ‘Electrical Machinery’, Khanna Publishers, 2003.

REFERENCES

1. A.E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, ‘Electric Machinery’, Tata McGraw Hill publishing Company Ltd, 2003.
2. J.B. Gupta, ‘Theory and Performance of Electrical Machines’, S.K.Kataria and Sons, 2002.
3. K. Murugesh Kumar, ‘Electric Machines’, Vikas Publishing House Pvt Ltd, 2002.

MICRO LESSON PLAN

EE2302 - ELECTRICAL MACHINES II

AIM

To expose the students to the concepts of synchronous and asynchronous machines and analyze their performance**.**

DESCRIPTION:

With the development of the technology and the way in which human labour is get- ting minimized and the comforts increasing tremendously the use of electrical energy is ever increasing. Basically electric power is the main source of energy for carrying out many functions, as it is a clean and efficient energy source, which can be easily transmitted over long distances. With the availability of Transformer for changing the voltage levels to a very high value (of say 132kV to 400kV) the use of AC power has increased rapidly and the DC power is used only at remote places where AC power cannot be supplied through power lines or cables or for a few social purposes.

A synchronous generator is an electrical machine producing alternating emf (Electromotive force or voltage) of constant frequency. In our country the standard commercial frequency of AC supply is 50 Hz. In U.S.A. and a few other countries the frequency is 60 Hz. The AC voltages generated may be single phase or 3-phase depending on the power supplied. For low power applications single phase generators are preferable. The basic principles involved in the production of emf and the constructional details of the generators are discussed below.

The induction machine was invented by NIKOLA TESLA in 1888. Right from its inception its ease of manufacture and its robustness have made it a very strong candidate for electromechanical energy conversion. It is available from fractional horsepower ratings to megawatt levels. It finds very wide usage in all various application areas. The induction machine is an AC electromechanical energy conversion device. The machine interfaces with the external world through two connections (ports) one mechanical and one electrical. The mechanical port is in the form of a rotating shaft and the electrical port is in the form of terminals where AC supply is connected. There are machines available to operate from three phase or single phase electrical input. In this module we will be discussing the three phase induction machine. Single phase machines are restricted to small power levels.

OBJECTIVES

To impart knowledge on

1. Construction and performance of salient and non – salient type synchronous generators.
2. Principle of operation and performance of synchronous motor.
3. Construction, principle of operation and performance of induction machines.
4. Starting and speed control of three-phase induction motors.
5. Construction, principle of operation and performance of single phase induction motors and special machines.

MICRO LESSON PLAN

EE2302 - ELECTRICAL MACHINES II

weak	No. of Hours	LECTUR TOPICS	Reference / Text book
1. SYNCHRONOUS GENERATOR			
1 st weak	1	Constructional details – Types of rotors – EMF Equation (AV class)	R1
	2	Armature reaction-Synchronous reactance	T2
	3	Synchronizing torque - Change of excitation and mechanical input	T2
	4	Two reaction theory	T2
	5	Determination of direct and quadrature axis synchronous reactance using slip test – Operating characteristics - Capability curves	T1
2 nd weak	6-8	Voltage regulation – EMF, MMF ,ZPF and A.S.A methods	T1
	9	Synchronizing and parallel operation	T1
	10-12	PROBLEM	R3
2. SYNCHRONOUS MOTOR			
3 rd weak	1	Principle of operation - Operation on infinite bus bars	T2
	2	V-curves	T1
	3	Power input and power developed equations	T1
	4-5	Starting methods (AV class)	T1
4th weak	6-7	Current loci for constant power input, constant excitation and constant power developed.	T1
	8	Torque equation	T1
	9- 11	PROBLEM	R3
3. THREE PHASE INDUCTION MOTOR			

5th weak	1	Constructional details – Types of rotors – Principle of operation	T1
	2	Slip & Slip-torque characteristics	T1
	3-4	Equivalent circuit	T1
	5	Condition for maximum torque – Losses and efficiency	T1
	6	Load test - No load and blocked rotor tests & Separation of no load losses	T1
6th weak	7-10	Circle diagram & Problems	T1
	11-12	Double cage rotors – Induction generator – Synchronous induction motor. (AV class)	T1
	13-15	PROBLEM	R3
4. STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR			
7 th weak	1	Need for starting – Types of starters	T2
	2	Rotor resistance, Autotransformer and Star-delta starters	T2
	3	Speed control(AV class)	T1
	4	Change of voltage, torque, number of poles and slip	T1
	5	Cascaded connection	T1
8 th weak	6-7	Slip power recovery scheme.	T1
	8-10	PROBLEM	R3
5. SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES			
9th weak	1	Constructional details of single phase induction motor – Double revolving field theory and operation	T1
	2-3	Equivalent circuit – No load and blocked rotor test	T1
	4	Starting methods of single-phase induction motors(AV class)	T1
	5-6	Shaded pole induction motor - Linear reluctance motor	T1
10 th weak	7-8	Repulsion motor - Hysteresis motor - AC series motor.	T1
	9	Double revolving field theory and operation – Performance analysis	T1
	10-12	PROBLEM	R3

SOME OTHER SYLLABUS COVERAGE BOOKS:

1. ELECTRICAL TECHNOLOGY (VOLUME II) –B.L.THERAJA, A.K. THERAJA- S.CHAND PUBLICATION

3. ELECTRICAL MACHINES II - GNANVADIVAL – ANURADHA PUBLICATION

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