



Electrical Machines - II

Question bank

III - B.TECH. / V- SEMESTER

Regulation: R20

Compiled by

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PRE-REQUISITES: A Course on Electrical Machines - I

COURSE EDUCATIONAL OBJECTIVES: On successful completion of the course, students will be able to

1. Impart knowledge on construction, working of induction machines and analyze the behavior of induction machines for various operating conditions.
2. Understand methods of starting and speed control of Induction motors.
3. Demonstrate knowledge on construction and performance of synchronous generators.
4. Demonstrate knowledge on parallel operation of synchronous generators and analyze effect of change of excitation and mechanical power input.
5. Impart knowledge on Construction, principle of operation and performance of single-phase induction motors and special machines.

UNIT – 1: THREE PHASE INDUCTION MOTORS

Principle of operation, Constructional details, Rotating Magnetic field, Types of rotors, Slip, Stator and Rotor current frequencies, Development of torque and torque calculations, Torque-Speed Characteristics, Power flow and performance calculations, Equivalent circuit, Calculation of equivalent circuit parameters from No-load and Rotor-blocked tests.

UNIT – 2: STARTING AND SPEED CONTROL METHODS

Predetermination of performance characteristics using circle diagram and load test, Starting of Induction motors using Rheostat/reactor starter, Auto-transformer starter, Star-Delta starter, and Rotor Resistance starter, Crawling and cogging, Brief description of the induction motor speed control using Voltage control, frequency control, pole changing, rotor resistance control, cascading, and rotor EMF injection, Induction generator and principle of operation, Double-cage rotors.

UNIT – 3: SYNCHRONOUS GENERATORS

Basic requirements, Constructional details, EMF equation, Effect of chording and distribution of winding, Armature reaction, Phasor diagram, Regulation of Synchronous Generators using EMF, MMF and ZPF method.

UNIT – 4: PARALLEL OPERATION OF SYNCHRONOUS GENERATORS

Synchronization Of Alternators, Parallel Operation Of Two-Alternators, Parallel Operation Of Synchronous Generator To Infinite Bus, Sharing Of Real And Reactive Powers, Capability Curve, Salient-Pole Synchronous Machine, Two-Reaction Theory, Determination Of Direct Axis And Quadrature Axis Reactances Of Salient-Pole Machines, Power-Angle Characteristics Of Cylindrical And Salient-Pole Machines.

UNIT – 5: SYNCHRONOUS AND SINGLE PHASE MOTORS

Principle of operation, starting methods, phasor diagram, effect of changing load and changing excitation on machine performance, V and Inverter 'V' curves, Hunting, Damper winding, power developed by synchronous motor. Single phase induction motors-Double- field revolving theory, principle of operation of split phase, capacitor start, capacitor start and run motors.



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DEPARTMENT of ELECTRICAL AND ELECTRONICS ENGINEERING

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Course Outcomes:

On successful completion of the course, students will be able to		POs related to COs
CO1	Analyze the behavior of induction machines for various operating conditions.	PO1, PO2 & PSO1, PSO2
CO2	Demonstrate knowledge on Methods of Starting and Speed Control and design suitable accessories/techniques for the starting and speed control of induction motors.	PO1, PO2, PO3 & PSO1, PSO2
CO3	Demonstrate knowledge on construction and performance of synchronous generator.	PO1, PO2, PO3 & PSO1, PSO2
CO4	Acquire knowledge on operation of synchronous motor, method of starting of synchronous motor and mathematical analysis for power developed.	PO1, PO2, PO3, PO4 & PSO1, PSO2
CO5	Demonstrate knowledge on construction and performance of single-phase induction motor and special machines.	PO1, PO2, PO3, PO4 & PSO1, PSO2

Text Books:

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

Reference Books:

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. M G SAY 'Electrical Machines'.
4. KOSAO 'Electrical Machines and transformers'.

REFERENCE WEBSITE LINK:

<https://nptel.ac.in/courses/108/105/108105017/>

CO-PO MAPPING:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	2	3
CO2	3	1	1	-	-	-	-	-	-	-	-	-	2	3
CO3	3	1	1	-	-	-	-	-	-	-	-	-	2	3
CO4	3	1	1	1	-	-	-	-	-	-	-	-	2	3
CO5	3	1	1	1	-	-	-	-	-	-	-	-	2	3
CO	3	1	1	1	-	-	-	-	-	-	-	-	2	3



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Question No.	Questions	PO Attainment
UNIT – I: THREE PHASE INDUCTION MOTORS		
PART-A (Two Marks Questions)		
1	Define slip in Induction motor.	PO1
2	List out the applications 3-phase induction motor.	PO1
3	Draw the equivalent circuit of 3-phase induction motor.	PO2
4	What is the effect of skewing the rotor slots of an induction motor?	PO1
5	What will be the effect on torque developed by an induction motor if applied voltage reduced to half with frequency unchanged?	PO1
6	What is the procedure to conduct the blocked rotor test on 3-phase induction motor?	PO1
7	Write the merits and demerits of slip-ring induction motor.	PO1
8	How can the direction of rotation of three phase induction motor can be reversed?	PO1
9	What are the fundamental characteristics of a rotating magnetic field?	PO1
10	State the conditions of maximum torque developed in three phase induction motor.	PO2
11	Draw the torque-slip characteristics of three phase induction motor.	PO1
PART-B (Ten Marks Questions)		
1	Draw the power flow diagram of a 3 phase induction motor and explain each stage?	PO1, PO2
2	Explain the principle of operation of 3-phase induction motor and explain how the rotating magnetic field is produced by 3-phase currents.	PO1, PO2, PO4
3	Derive an expression for the torque of an induction motor and obtain the condition for maximum torque.	PO1, PO2
4	Explain the tests required to be performed to obtain the data for the circle diagram	PO1, PO2, PO4
5	Describe the construction and principle of operation of a 3-phase induction motor with neat sketch.	PO1, PO2, PO4

Question No.	Questions	PO Attainment
UNIT – 2: STARTING AND SPEED CONTROL METHODS		
PART-A (Two Marks Questions)		
1	What is crawling in an induction motor?	PO1
2	What is the condition for maximum torque at the time of starting of 3-phase induction motor?	PO1
3	What is the condition for maximum torque under running condition of 3-phase induction motor?	PO1
4	What are the limitations of speed control by conventional methods?	PO1
5	Why starting methods are needed for 3- Φ induction motor?	PO1
6	What is an induction generator?	PO1
7	What are the advantages of double squirrel cage induction motor?	PO1
8	Define the term cogging.	PO1
9	Name the type of starters used in 3 phase induction motors.	PO1



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10	Why the starters are necessary for the induction motor?	PO1
11	What is meant by plugging?	PO1
12	List out the methods of speed control of three phase induction motor.	PO1
13	Name the method of speed control used only for slip ring induction motor.	PO1
14	What are the disadvantages of rotor rheostat speed control method?	PO1, PO2
15	State two advantages of speed control of induction motor by injecting an emf in the rotor circuit?	PO1

PART-B (Ten Marks Questions)

1	Write a brief note on double cage rotor induction motors.	PO1, PO2, PO4
2	Explain in detail the construction of circle diagram of an induction motor	PO1, PO2, PO4
3	Illustrate the phenomenon of cogging and crawling in induction motor.	PO1, PO2, PO4
4	Explain the operation of induction machine as a generator with neat diagram.	PO1, PO2, PO4
5	Explain the methods of starting of induction motor with neat sketches.	PO1, PO2, PO4
6	Explain the speed control of induction motor from stator side.	PO1, PO2, PO4
7	Why starters are necessary for starting induction motors? What are the various types of starters? Explain star-delta type starter in detail.	PO1, PO2, PO4
8	Explain the cascaded operation of three phase induction motor.	PO1, PO2, PO4

Question No.	Questions	PO Attainment
UNIT – 3: SYNCHRONOUS GENERATORS		
PART-A (Two Marks Questions)		
1	What are the types of synchronous machines with respect to its rotor construction?	PO1
2	What is the relation between electrical degree and mechanical degree?	PO1
3	Why short-pitch winding is preferred over full pitch winding?	PO1
4	Define distribution factor.	PO1
5	Define the term pitch factor.	PO1
6	What is meant by armature reaction in alternators?	PO1
7	Define the term voltage regulation of an alternators.	PO1
8	Distinguish between full pitch coil and short pitch coil.	PO1
9	What are the various functions of damper winding provided with alternator?	PO1
10	Why distributed windings are preferred over concentrated windings in making armature winding of synchronous machines?	PO1
11	Why regulation of large alternators is determined by indirect methods?	PO1
12	Explain why the value of regulation calculated by synchronous impedance method is more than the actual value.	PO1
PART-B (Ten Marks Questions)		
1	Describe with neat sketches the constructional details of a salient pole type alternator.	PO4
2	Explain clearly the ZPF (potier triangle) method of determining the regulation of an alternator.	PO3



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3	Explain EMF method of determining the regulation of an alternator.	PO3
4	List the methods used to predetermine the voltage regulation of synchronous machine and explain the MMF method.	PO2
5	Derive emf equation of an alternator. Also derive the expressions for distribution factor and pitch factor.	PO2
6	Explain the term armature reaction. Explain armature reaction at lagging power-factor load in a synchronous generator.	PO3

Question No.	Questions	PO Attainment
UNIT – 4: PARALLEL OPERATION OF SYNCHRONOUS GENERATORS		
PART-A (Two Marks Questions)		
1	What are the conditions that should be satisfied for parallel operation of alternators?	PO1
2	List out the various advantages of connecting synchronous generators in parallel.	PO1
3	List out the various methods used for synchronization of alternators.	PO1
4	State under what conditions an alternator is said to be floating on the bus-bar.	PO1, PO2
5	What is called capability curve?	PO1, PO2
6	What is direct axis and quadrature axis reactance of a salient pole synchronous machine?	PO1, PO2
7	Express the importance of power angle characteristics of a synchronous machine.	PO1, PO2
PART-B (Ten Marks Questions)		
1	Describe a method of synchronizing the three-phase alternator to infinite bus bar with relevant circuit diagram.	PO1, PO2, PO4
2	Explain the two-reaction theory of salient pole synchronous machine.	PO1, PO2, PO4
3	What is synchronizing power of an alternator? Derive an expression for synchronizing power between the two alternators connected in parallel	PO1, PO2, PO4
4	Explain the determination of direct and quadrature axis synchronous reactance by using slip test.	PO1, PO2, PO4
5	State and explain the condition for parallel operation of alternators.	PO1, PO2, PO4
6	Explain the effect of change of excitation of a synchronous generator connected to an infinite bus-bar.	PO1, PO2, PO4

Question No.	Questions	PO Attainment
UNIT – 5: SYNCHRONOUS AND SINGLE PHASE MOTORS		
PART-A (Two Marks Questions)		
1	Why a 3-phase synchronous motor will always run at synchronous speed?	PO1, PO2
2	Mention the methods of starting of 3-phase synchronous motor.	PO1, PO2
3	What is meant by hunting of a synchronous motor?	PO1, PO2
4	What are the uses of damper winding in synchronous motor?	PO1, PO2
5	What is meant by 'Torque Angle'?	PO1
6	What are the main parts of synchronous motor?	PO1, PO2



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7	Why synchronous motor is not a self-starting motor?	PO1
8	What are the causes of hunting?	PO1
9	Write down the application of synchronous motor.	PO1
10	What are V curves?	PO1
11	How the direction of rotation of a single phase induction motor reversed?	PO1
12	Why single phase induction motor is not a self-starting motor?	PO1
13	What is the function of capacitor in single phase induction motor?	PO1
14	List out the various applications of single phase induction motor.	PO1
15	What kind of motors used in ceiling fan and wet grinders?	PO1
16	State the double revolving field theory.	PO1
17	Why single phase induction motors have low PF?	PO1
18	Why an induction motor never runs at its synchronous speed?	PO1, PO2
19	Why an induction motor is called as rotating transformer?	PO1
20	What are the advantages of capacitor start induction motor over split-phase induction motor?	PO1
<u>PART-B (Ten Marks Questions)</u>		
1	Explain briefly about the V and inverted V curves and mention its significant.	PO1, PO2, PO4
2	Explain the effect of changing field current excitation at constant load.	PO1, PO2, PO4
3	Describe the various methods of starting the synchronous motor	PO1, PO2, PO4
4	Derive the expression for power developed in a synchronous motor. Also find the condition for maximum power developed	PO1, PO2, PO4
5	Explain the operation of single phase induction motor using double field revolving theory.	PO1, PO2, PO4
6	Explain the operation of split-phase induction motor with neat diagram.	PO1, PO2, PO4
7	Explain the working principle of single phase induction motor.	PO1, PO2, PO4
8	Explain with a neat diagram the following types of single phase induction motor. (i). Capacitor start, (ii). Capacitor start and capacitor run induction motor.	PO1, PO2, PO4

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