KKR & KSR INSTITUTE OF TECHNOLOGY & SCIENCES

(Approved by AICTE, Delhi, Affiliated to JNTU, Kakinada)

Accredited with "A" Grade by NAAC

Department of Electrical and Electronics Engineering

Academic year: 2017-18 **Year/Semester: II/II** **Regulation: R16**

Name of the subject: ELECTRICAL MACHINES-II

This course covers the topics on 3-phase induction motor, 1-phase induction motor and synchronous machines which have wide application in power systems. The main aim of the course is to provide a detailed analysis of operation and performance of 3-phase induction motor, 1-phase induction motor and synchronous machines. In addition, it also covers voltage regulation and parallel operation of synchronous generators.

LEARNING OBJECTIVES:

- Understand the principle of operation and performance of 3-phase induction motor.
- Quantify the performance of induction motor and induction generator in terms of torque and slip.
- To understand the torque producing mechanism of a single phase induction motor.
- To understand the principle of emf generation, the effect of armature reaction and predetermination of voltage regulation in synchronous generators.
- To study parallel operation and control of real and reactive powers for synchronous generators.
- To understand the operation, performance and starting methods of synchronous motors.

SYLLABUS

UNIT-I

3-phase Induction Motors

Construction details of cage and wound rotor machines - production of rotating magnetic field - principle of operation - rotor emf and rotor frequency - rotor current and pf at standstill and during running conditions - rotor power input, rotor copper loss and mechanical power developed and their interrelationship – equivalent circuit – phasor diagram

UNIT-II

Characteristics, starting and testing methods of Induction Motors

Torque equation - expressions for maximum torque and starting torque - torque slip characteristic - double cage and deep bar rotors - crawling and cogging – speed control of induction motor with V/f method – no load and blocked rotor tests - circle diagram for predetermination of performance– methods of starting – starting current and torque calculations – induction generator operation (Qualitative treatment only)

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UNIT – III:

Single Phase Motors

Single phase induction motors – Constructional features and equivalent circuit Problem of starting–Double revolving field theory–Starting methods, shaded pole motors, AC Series motor.

UNIT–IV:

Construction, Operation and Voltage Regulation of Synchronous generator

Constructional features of non–salient and salient pole type – Armature windings –Distributed and concentrated windings – Distribution– Pitch and winding factors –E.M.F equation– Improvements of waveform and armature reaction–Voltage regulation by synchronous impedance method– MMF method and Potier triangle method–Phasor diagrams–Two reaction analysis of salient pole machines and phasor diagram.

UNIT –V:

Parallel operation of synchronous generators

Parallel operation with infinite bus and other alternators – Synchronizing power – Load sharing – Control of real and reactive power– Numerical problems.

UNIT–VI:

Synchronous motor – operation, starting and performance

Synchronous Motor principle and theory of operation– Phasor diagram – Starting torque– Variation of current and power factor with excitation –Synchronous condenser –Mathematical analysis for power developed– Hunting and its suppression – Methods of starting – Applications.

PREREQUISITE COURSES		
S.no	**Name of the course**	**Year/Semester**
1	Electrical Circuit Analysis-I	I/II
2	Electrical Circuit Analysis-II	II/I
3	Electrical Machines-I	II/I

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COURSE OUTCOMES

Co. No	Course Outcome	Taxonomy Level
C225.1	Draw the equivalent circuit of a three phase induction motor.	Application
C225.2	Determine the performance parameters of three phase induction motor.	Application
C225.3	Explain the constructional features and operation of single phase AC motors.	Comprehension
C225.4	Calculate the voltage regulation of synchronous generator.	Application
C225.5	Explain the Parallel operation with infinite bus and other alternators.	Comprehension
C225.6	Explain the Mathematical analysis for power developed in synchronous motor.	Comprehension

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C225.1	3	2	1									
C225.2	3	2	1									
C225.3	3		1									
C225.4		2	1									
C225.5	3	2	1	2								
C225.6	3	2	1	2								

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LESSON PLAN

L /T No.	Topics covered	Teaching Aid	Text Book / Reference Book / Web	Page Numbers
Unit -1: 3-phase Induction Motors				
L-01	Construction details of cage and wound rotor machines	GB&PC	R6	643-646
L-02	Production of rotating magnetic field	GB&PC	R6	140-142
L-03	Principle of operation	GB&PC	R6	647-648
L-04	Slip, rotor emf and rotor frequency and problems	GB&PC	R6	649-651
L-05	Rotor current and pf at standstill and during running conditions	GB&PC	R6	651-652
L-06	Rotor power input, rotor copper loss and mechanical power developed and their interrelationship	GB&PC	R6	662-664
T-01	Problems	GB&PC	R6	666-667
L-07	Equivalent circuit	GB&PC	R6	671-672
L-08	Phasor diagram	GB&PC	R6	672-673
UNIT-II:Characteristics, starting and testing methods of Induction Motors				
L-09	Torque equation - expressions for maximum torque and starting torque	GB&PC	R6	653-654
L-10	Torque slip characteristic	GB&PC	R6	655
T-02	Problems	GB&PC	R6	659-660
L-11	Double cage and deep bar rotors	GB&PC	R6	693-694
L-12	Crawling and Cogging	GB&PC	R6	689-690
L-13	Speed control of induction motor with V/f method	GB&PC	R6	721-723

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Name of the subject: ELECTRICAL MACHINES-II

L-14	Speed control of induction motor with V/f method	GB&PC	R6	721-723
L-15	No load and Blocked rotor tests	GB&PC	R6	675-678
L-16	No load and Blocked rotor tests	GB&PC	R6	675-678
L-17	Circle diagram for predetermination of performance parameters	GB&PC	R6	684-685
T-03	Problems	GB&PC	R6	685-687
T-04	Problems	GB&PC	R6	687-687
L-18	Methods of starting(starting current and torque calculations)	GB&PC	R6	711-714
L-19	Methods of starting(starting current and torque calculations)	GB&PC	R6	714-716
L-20	Methods of starting(starting current and torque calculations)	GB&PC	R6	720-721
T-05	Problems	GB&PC	R6	717-719
L-21	Induction generator operation (Qualitative treatment only)	GB&PC	R6	801-803
UNIT – III: Single Phase Motors				
L-22	Single phase induction motors – Constructional features	GB&PC	R6	752-753
L-23	Equivalent circuit	GB&PC	R6	756-757
L-24	Double revolving field theory	GB&PC	R6	754-755
L-25	Performance characteristics	GB&PC	R6	757-758
T-06	Problems	GB&PC	R6	758-760
L-26	Starting methods	GB&PC	R6	763-765
L-27	Starting methods	GB&PC	R6	765-766
L-28	Starting methods	GB&PC	R6	766-767
L-29	Starting methods	GB&PC	R6	768-770
L-30	Starting methods	GB&PC	R6	770
L-31	Shaded pole motors	GB&PC	R6	771-772

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L-32	AC Series motor	GB&PC	R6	773-774
UNIT–IV:Construction, Operation and Voltage Regulation of Synchronous generator				
L-33	Constructional features of non–salient and salient pole type	GB&PC	R6	511-513
L-34	Armature windings –Distributed and concentrated windings	GB&PC	R6	517-522
L-35	Distribution– Pitch and winding factors	GB&PC	R6	522-524
L-36	E.M.F equation	GB&PC	R6	524
T-07	Problems	GB&PC	R6	525-526
L-37	Improvements of waveform and armature reaction	GB&PC	R6	527-531
L-38	Improvements of waveform and armature reaction	GB&PC	R6	527-531
L-39	Voltage regulation by synchronous impedance method– MMFmethod	GB&PC	R6	531-535
L-40	Voltage regulation by synchronous impedance method– MMFmethod	GB&PC	R6	531-535
T-08	Problems	GB&PC	R6	540-541
L-41	Voltage regulation by Potier triangle method	GB&PC	R6	543-544
T-09	Problems	GB&PC	R6	545
L-42	Two reaction analysis of salient pole machines and phasor diagram	GB&PC	R6	549-552
L-43	Two reaction analysis of salient pole machines and phasor diagram	GB&PC	R6	549-552
UNIT –V:Parallel operation of synchronous generators				
L-44	Parallel operation with infinite bus and other alternators	GB&PC	R6	612
L-45	Parallel operation with infinite bus and other alternators	GB&PC	R6	613-614
L-46	Parallel operation with infinite bus and other alternators	GB&PC	R6	615-616
L-47	Synchronizing power	GB&PC	R6	616-617
L-48	Effects on parallel operation	GB&PC	R6	617-619
L-49	Load sharing	GB&PC	R6	620
T-09	Problems	GB&PC	R6	621-622
L-50	Control of real and reactive power	GB&PC	R6	629-630

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T-10	Problems	GB&PC	R6	630-631
UNIT–VI:Synchronous motor – operation, starting and performance				
L-51	Synchronous Motor principle and theory of operation	GB&PC	R6	574-575
L-52	Phasor diagram	GB&PC	R6	579-580
L-53	Starting torque-Variation of current and power factor with excitation	GB&PC	R6	581,593-595
L-54	Starting torque-Variation of current and power factor with excitation	GB&PC	R6	581,593-595
L-55	Synchronous condenser	GB&PC	R6	599,601
L-56	Mathematical analysis for power developed	GB&PC	R6	580-581
L-57	Hunting and its suppression	GB&PC	R6	601-602
L-58	Methods of starting – Applications.	GB&PC	R6	602,604
Total No of Lectures = 58,Total No of Tutorials=10			**Total**	**68**

Learning Resourses:GB&CP: Glass board & Chalk Piece, **T: Tutorial, L: Lecture**

TEXT BOOKS:

1. Electrical Machines – P.S. Bhimbra, Khanna Publishers
2. Electric Machinery by A.E.Fitzgerald,Charleskingsley,StephenD.Umans, TMH

REFERENCE BOOKS:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth,McGrawHill Publications, 4th edition
2. Electrical Machines by R.K.Rajput, Lakshmi publications,5th edition
3. Electrical Machinery by AbijithChakrabarthi and SudhiptaDebnath,McGraw Hill education 2015
4. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010
5. Electric Machines by MulukutlaS.Sarma&Mukeshk.Pathak, CENGAGE Learning.
6. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons

FACULTY **HOD**

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EXPERIMENTS RELATED TO COURSE	
S.No	**Experiment**
1	Brake test on three phase Induction Motor
2	No–load & Blocked rotor tests on three phase Induction motor
3	Regulation of a three –phase alternator by synchronous impedance &m.m.f.Methods
4	Regulation of three–phase alternator by Potier triangle method
5	V and Inverted V curves of a three—phase synchronous motor.
6	Determination of Xd and Xq of a salient pole synchronous machine
7	Equivalent circuit of single phase induction motor
8	Speed control of induction motor by V/f method.
9	9. Determination of efficiency of three phase alternator by loading with three phaseinduction motor.
10	Power factor improvement of single phase induction motor by using capacitors andload test on single phase induction motor.

QUESTION BANK