JEPPIAAR ENGINEERING COLLEGE
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION OF INSTITUTION

To build Jeppiaar Engineering College as an institution of academic excellence in technology and management education, leading to become a world class University.

MISSION OF INSTITUTION

- To excel in teaching and **learning, research and innovation** by promoting the principles of scientific analysis and creative thinking.
- To participate in the production, **development, dissemination of knowledge** and interact with **national and international communities.**
- To equip students with ethical **values, and life skills** that would enrich their lives and enable them to meaningfully contribute to the **progress of the society.**
- To prepare students for **higher studies and lifelong learning,** enrich them with the **practical and entrepreneurial skills** necessary to excel as future professionals and contribute to **Nation's economy.**

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

VISION OF THE DEPARTMENT

The Department of Electrical and Electronics Engineering strives to be a Centre of Excellence in education and technical research, in the endeavour of which the Department will continually update the teaching methodologies, progress in the emerging technologies and continue to play a vital role in the development of the society.

MISSION OF THE DEPARTMENT

M1	To develop the ability to **learn** and work creatively that would enhance the ability of both students and faculty to do **innovative research**.
M2	To **create** and maintain state-of-the art facilities which provide students and faculty with opportunities to analyse, apply and **disseminate knowledge globally**.
M3	To impart the knowledge in essential interdisciplinary fields which will enhance the **interpersonal skills**, team work, professional **ethics** and make them work effectively for their own benefit and the **betterment of the society**.
M4	Prepare students for **lifelong learning** of theoretical and **practical concepts** to face intellectual, **economical** and career challenges.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 01	Strengthen the knowledge in Electrical and Electronics Engineering to enable them **work** for modern industries by promoting energy conservation and sustainability.
PEO 02	Enrich analytical, creative and critical **logical reasoning** skills to solve problems faced by emerging domains of electrical and electronics engineering industries worldwide.
PEO 03	Develop effective communication and inter-personal skills to work with enhanced team spirit in multidisciplinary projects with a broader **ethical**, professional, economical and **social** perspective.
PEO 04	Prepare the students either to establish **start ups** or to pursue **higher education** at reputed institutions.

PROGRAM SPECIFIC OUTCOME (PSOs)

PSO 1	**Professional Skills:** Apply the knowledge of Mathematics, Science and Engineering to solve real time problems in the field of **Power Electronics, Electrical Drives, Power Systems, Control Systems and Instrumentation**.
PSO 2	**Research and Innovation:** Analyze and synthesize circuits by solving complex engineering problems to obtain the **optimal solution** using effective software tools and hardware prototypes in the field of robotics and renewable energy systems.
PSO 3	**Product development:** Develop concepts and **products** by applying ideas of electrical domain into other diversified engineering domains.

SYLLABUS

UNIT I - SYNCHRONOUS GENERATOR

Constructional details – Types of rotors –winding factors- emf equation – Synchronous reactance –Armature reaction – Phasor diagrams of non salient pole synchronous generator connected to infinite bus--Synchronizing and parallel operation – Synchronizing torque -Change of excitation and mechanical input- Voltage regulation – EMF, MMF, ZPF and A.S.A methods – steady state power angle characteristics– Two reaction theory –slip test -short circuit transients - Capability Curves

UNIT II - SYNCHRONOUS MOTOR

Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power developed-Hunting – natural frequency of oscillations – damper windings- synchronous condenser.

UNIT III - THREE PHASE INDUCTION MOTOR

Constructional details – Types of rotors –- Principle of operation – Slip –cogging and crawling- Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of losses – Double cage induction motors –Induction generators – Synchronous induction motor.

UNIT IV- STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR

Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star-delta starters – Speed control – Voltage control, Frequency control and pole changing – Cascaded connection-V/f control – Slip power recovery scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.

UNIT V-SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors – Capacitor-start capacitor run Induction motor- Shaded pole induction motor - Linear induction motor – Repulsion motor - Hysteresis motor - AC series motor- Servo motors- Stepper motors - introduction to magnetic levitation systems.

L: 45, T: 15, Total = 60 Periods

Books Referred:

TEXT BOOKS:

1. A.E. Fitzgerald, Charles Kingsley, Stephen. D.Umans, ‘Electric Machinery’, Tata Mc Graw Hill publishing Company Ltd, 2003.
2. D.P. Kothari and I.J. Nagrath, ‘Electric Machines’, Tata McGraw Hill Publishing Company Ltd, 2002.
3. P.S. Bhimbhra, ‘Electrical Machinery’, Khanna Publishers, 2003.

REFERENCES:

1. M.N.Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2009.
2. Charless A. Gross, “Electric /Machines, “CRC Press, 2010.
3. K. Murugesh Kumar, ‘Electric Machines’, Vikas Publishing House Pvt. Ltd, 2002.
4. Syed A. Nasar, Electric Machines and Power Systems: Volume I, Mcgraw -Hill College; International ed Edition, January 1995.
5. Alexander S. Langsdorf, Theory of Alternating-Current Machinery, Tata McGraw Hill Publications, 2001.

Course code& Name: **EE6504 & Electrical Machines-II**
Degree/Programme: **B.E/EEE** Semester: **V** Section: **A, B**
Duration: **JUNE-OCT 2018** Regulation: **2013/AUC**
Name of the Staff:

AIM: To expose the students to the concepts of synchronous and asynchronous machines and analyze their performance. To expose the students to the concepts of various types of electrical machines and applications of electrical machines. To understand the construction, working principle, applications of Alternators, synchronous motor, three phase & single phase induction motor and special machines. To understand the various testing and analysis techniques.

OBJECTIVES:

- To impart knowledge on Construction and performance of salient and non – salient type synchronous generators.
- To impart knowledge on Principle of operation and performance of synchronous motor.
- To impart knowledge on Construction, principle of operation and performance of induction machines.
- To impart knowledge on Starting and speed control of three-phase induction motors.
- To impart knowledge on Construction, principle of operation and performance of single phase Induction motors and special machines.

COURSE OUTCOMES:

C	Course Outcomes
C3.04.1	Understand the constructional details and the performance of salient and non - salient type synchronous generators.
C3.04.2	Discuss the Principle of operation and analyse the performance of synchronous motor
C3.04.3	Infer the construction, principle of operation and performance analysis of induction machines
C3.04.4	Understand the starting, Braking and speed control of three-phase induction motors.
C3.04.5	Discuss the construction, principle of operation and performance of single phase induction motors and special

Mapping of Course Outcomes(COs), Course(C),ProgramSpecificOutcomes (PSOs)with Program Outcomes. (POs)– [Levels of correlation:3 (High),2 (Medium), 1(Low)]

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C3.04.1	3	3	2	3	-	2	1	-	-	2	-	2	3	2	1
C3.04.2	3	3	2	3	-	1	1	-	-	2	-	2	3	1	1
C3.04.3	3	3	2	3	-	1	1	-	-	2	-	2	3	2	1
C3.04.4	3	3	2	2	-	1	1	-	-	2	-	2	3	1	1
C3.04.5	3	3	2	2	-	1	1	-	-	3	-	2	3	2	1

UNIT - I	SYNCHRONOUS GENERATOR				Target Periods: 12	
Sl N o	**Contents**	**CO Statement**	**Book Reference & Page No**	**Delivery method**	**Delivery Periods**	**Knowledge Level**
1	Constructional details, Types of rotors	C3.04.1	RB3: 25.1 - 25.9	Chalk & board / PPT	**1**	U & An
2	winding factors- emf equation, Synchronous reactance –Armature reaction	C3.04.1	TB2: 424-430	Chalk & board / PPT	**1**	U & An
3	Phasor diagrams of non salient pole synchronous generator connected to infinite bus	C3.04.1	TB2: 442-445	Chalk & board / PPT	**1**	U & An
4	Synchronizing and parallel operation – Synchronizing torque	C3.04.1	TB2: 484-486	Chalk & board / PPT	**1**	U & An
5	Change of excitation and mechanical input	C3.04.1	RB3: 28.20-28.23	Chalk & board / PPT	**1**	U & An
6	Voltage regulation – EMF, MMF, ZPF and A.S.A methods	C3.04.1	TB3: 557-572	Chalk & board / PPT	**1**	U & An
7	steady state power angle characteristics	C3.04.1	TB2: 424-430	Chalk & board / PPT	**1**	U & An
8	Two reaction theory –slip test	C3.04.1	TB2: 442-445	Chalk & board / PPT	**1**	U & An
9	short circuit transients - Capability Curves	C3.04.1	TB2: 484-486	Chalk & board / PPT	**1**	U & An

UNIT II	SYNCHRONOUS MOTOR				Target Periods:12	
Sl No	**Contents**	**CO Statement**	**Book Reference & Page No**	**Delivery method**	**Delivery Hrs**	**Knowledge Level**
1	Principle of operation, Torque equation	C3.04.2	RB3: 30.2-30.3	Chalk & board / PPT	**1**	U & An
2	Operation on infinite bus bars	C3.04.2	RB3: 30.4-30.7	Chalk & board / PPT	**1**	U & An
3	V and Inverted V curves	C3.04.2	RB3: 30.28-30.33	Chalk & board / PPT	**1**	U & An
4	Power input and power developed equations, Starting methods	C3.04.2	RB3: 30.12-30.17	Chalk & board / PPT	**1**	U & An
5	Current loci for constant power Input	C3.04.2	RB3: 31.3-31.6	Chalk & board / PPT	**1**	U & An
6	constant excitation and constant power developed	C3.04.2	RB3: 31.7-31.10	Chalk & board / PPT	**1**	U & An
7	Hunting, Natural frequency of oscillations	C3.04.2	TB2: 486-489	Chalk & board / PPT	**1**	U & An
8	damper windings	C3.04.2	TB2: 489-490	Chalk & board / PPT	**1**	U & An
9	Synchronous Condenser	C3.04.2	TB3: 669-671	Chalk & board / PPT	**1**	U & An

UNIT III THREE PHASE INDUCTION MOTOR Target Periods: 12

Sl No	Contents	CO Statement	Book Reference & Page No	Delivery method	Delivery Hrs	Knowledge Level
1	Constructional details, Types of rotors, Principle of operation	C3.04.3	RB3: 17.1-17.9	Chalk & board / PPT	1	U & An
2	Slip –cogging and crawling	C3.04.3	TB2: 580-582	Chalk & board / PPT	1	U & An
3	Equivalent circuit	C3.04.3	TB2: 531-536	Chalk & board / PPT	1	U & An
4	Torque-Slip characteristics, Condition for maximum torque	C3.04.3	TB2: 539-545	Chalk & board / PPT	1	U & An
5	Losses and efficiency, Load test, No load and blocked rotor tests	C3.04.3	TB2: 547-555	Chalk & board / PPT	1	U & An
6	Circle diagram, Separation of losses	C3.04.3	TB2: 564-568	Chalk & board / PPT	1	U & An
7	Double cage induction motor	C3.04.3	TB2: 597-601	Chalk & board / PPT	1	U & An
8	Induction generators	C3.04.3	TB2: 603-606	Chalk & board / PPT	1	U & An
9	Synchronous induction motor	C3.04.3	RB3: 17.45-17.47	Chalk & board / PPT	1	U & An

UNIT IV - STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR Target Periods: 12

Sl No	Contents	CO Statement	Book Reference & Page No	Delivery method	Delivery Hrs	Knowledge Level
1	Need for starting, Types of starters	C3.04.4	TB3: 791-792	Chalk & board / PPT	1	U & An
2	DOL, Rotor resistance, Autotransformer and Star-delta starters	C3.04.4	TB3: 792-796	Chalk & board / PPT	1	U & An
3	Speed control, Voltage control, Frequency control	C3.04.4	TB2: 582-583	Chalk & board / PPT	1	U & An
4	pole changing, Cascaded connection, V/f control	C3.04.4	TB2: 586-597	Chalk & board / PPT	2	U & An
5	Slip power recovery scheme	C3.04.4	TB2: 618-621	Chalk & board / PPT	2	U & An
6	Braking of three phase induction motor	C3.04.4	RB3: 23.40-23.41	Chalk & board / PPT	1	U & An
7	Plugging, dynamic braking and regenerative braking	C3.04.4	RB3: 23.42-23.46	Chalk & board / PPT	1	U & An

UNIT V SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES Target Periods: 12

Sl No	Contents	CO Statement	Book Reference & Page No	Delivery method	Delivery Hrs	Knowledge Level
1	Constructional details of single phase induction motor	C3.04.5	RB3: 24.1-24.2	Chalk & board / PPT	1	U & An
2	Double field revolving theory and operation	C3.04.5	RB3: 24.2-24.5	Chalk & board / PPT	1	U & An

3	Equivalent circuit, No load and blocked rotor test	C3.04.5	RB3: 24.5-24.7	Chalk & board / PPT	**1**	U & An
4	Performance analysis	C3.04.5	RB3: 24.8-24.11	Chalk & board / PPT	**1**	U & An
5	Starting methods of single-phase induction motors, Capacitor-start capacitor run Induction motor	C3.04.5	RB3: 24.12-24.15	Chalk & board / PPT	**1**	U & An
6	Shaded pole induction motor - Linear induction motor, Repulsion motor	C3.04.5	RB3: 24.15-24.17	Chalk & board / PPT	**1**	U & An
7	Hysteresis motor, AC series motor	C3.04.5	TB2: 654-657	Chalk & board / PPT	**1**	U & An
8	Servo motors, Stepper motors	C3.04.5	TB2: 670-681	Chalk & board / PPT	**1**	U & An
9	Introduction to magnetic levitation systems.	C3.04.5	TB2: 681-685	Chalk & board / PPT	**1**	U & An

R- Remember, U- Understand, A- Apply, An- Analyze, E- Evaluate & C- Create.

Books:Text/Reference:

S.No		Title of the Book	Author	Publishe	Year
1	**TB1**	Electric Machinery	A.E. Fitzgerald, Charles Kingsley, Stephen. D.Umans	Tata Mc Graw Hill publishing Company Ltd,	2003
2	**TB2**	Electric Machines	D.P. Kothari & I.J. Nagrath	Tata Mc Graw Hill publishing Company Ltd,	2002
3	**TB3**	Electrical Machinery	P.S. Bhimbhra	Khanna Publishers	2003
4	**RB1**	Electrical Machines Theory and Practice	M.N.Bandyopadhyay	PHI Learning PVT LTD., New Delhi	2009
5	**RB2**	Electric Machines	Charless A. Gross	CRC Press	2010
6	**RB3**	Electric Machines	K. Murugesh Kumar	Vikas Publishing House Pvt. Ltd	2002
7	**RB4**	Electric Machines and Power Systems: Volume I	Syed A. Nasar	Mcgraw -Hill College; International ed Edition,	1995
8	**RB5**	Theory of Alternating-Current Machinery	Alexander S. Langsdorf	Tata Mc Graw Hill publishing Company Ltd,	2001

Comments Given by the Scrutinizing Committee Members	
Signature of the Scrutinizing	
Signature of the HOD	

EE6504-ELECTRICAL MACHINES-II

UNIT I

SYNCHRONOUS GENERATOR

PART A

1. Name the various types of alternators.

i. Turbo alternator ii. Salient pole alternator

2. Write the EMF equation of a three-phase alternator.

The emf equation of alternator is

$$E = 4.44\ K_c\ K_d \Phi\ f\ T \text{ volts}$$

Where

E = Induced emf per phase

K_c = Pitch factor

K_d = Distribution factor

T = No of turns connected in series in each phase

3. Why do cylindrical Alternators operate with steam turbines?

Steam turbines are found to operate at fairly good efficiency only at high speeds. The high speed operation of rotors tends to increase mechanical losses and so the rotors should have a smooth external surface. Hence, smooth cylindrical type rotors with less diameter and large axial length are used for Synchronous generators driven by steam turbines with either 2 or 4 poles.

4. Which type of Synchronous generators are used in Hydro-electric plants and why?

As the speed of operation is low for hydro turbines used in Hydro-electric plants, salient pole type Synchronous generators are used. These allow better ventilation and also have other advantages over smooth cylindrical type rotor.

5. What are the advantages of salient pole type construction used for Synchronous machines? (May2018)

Advantages of salient-pole type construction are :

- They allow better ventilation
- The pole faces are so shaped that the radial air gap length increases from the pole center to the pole tips so that the flux distribution in the air-gap is sinusoidal in shape which will help the machine to generate sinusoidal emf
- Due to the variable reluctance the machine develops additional reluctance power which is independent of excitation

6. How does electrical degree differ from mechanical degree?

Mechanical degree is the unit for accounting the angle between two points based on their mechanical or physical placement. Electrical degree is used to account the angle between two points in rotating electrical machines. Since all electrical machines operate with the help of magnetic fields, the electrical degree is accounted with reference to the magnetic field. 180 electrical degree is accounted as the angle between adjacent North and South poles.

$$\theta_{\text{electrical}} = \theta_{\text{mech.}}\ (P/2) \quad \text{where } P = \text{No.of poles}$$

7. Why is short pitch winding preferred over full-pitch winding ? (Nov2016)

Advantages

- Waveform of the emf can be approximately made to a sine wave and distorting harmonics can be reduced or totally eliminated.
- Conductor material , copper is saved in the back and front end connections due to less coil-span.
- Fractional slot winding with fractional number of slots/phase can be used which in turn reduces the tooth ripples.
- Mechanical strength of the coil is increased.

8. Define winding factor.

The winding factor k_w is defined as the ratio of phasor addition of emf induced in all the coils of each phase winding to their arithmetic addition of emf's.

9. Why are Alternators rated in kVA and not in kW?

The continuous power rating of any machine is generally defined as the power of the machine or apparatus can deliver for a continuous period so that the losses incurred in the machine gives rise to a steady temperature rise not exceeding the limit prescribed by the insulation class. Apart from the constant loss incurred in Alternators is the copper loss, occurring in the 3 –phase winding which depends on I^2 R, the square of the current delivered by the generator. As the current is directly related to apparent – power delivered by the generator, the Alternators have only their apparent power ratings in VA/kVA/MVA.

10. What do you mean by "single layer" and "double layer" winding?(Nov/Dec 2011)(May2017)

In single layer winding, there- is only one coil side per slot- But in double layer winding, in each slot there are two coil sides namely upper coil side and lower coil side. Hence, in single layer winding, the number of coils is half the number of slots, but in double layer winding, the number of coils is equal to the number of slots.

11. Compare the salient pole rotor and cylindrical pole rotor on stability point of view.

Salient pole rotor is of large diameter and small axial length. It is used for low speed alternator. Smooth cylindrical rotor is of smaller diameter and long axial length. Therefore it is used for high-speed turbo alternator.

12. Where the damper windings are located? What are their functions? (Nov/Dec 2011) (Nov2017)

Damper windings are provided in the pole shoes of the salient pole rotor. Slots or holes are provided in the pole shoes. Copper bars are inserted in the slots and the ends of all the bars in both the sides are short circuited by copper end rings to have a closed circuit. These windings are useful in preventing the hunting in alternators; they are also needed, in synchronous motor to provide the starting torque.

13. What are the causes of changes in terminal voltage of Alternators when loaded? (Nov/Dec 2012)

Variations in terminal voltage in Alternators on load condition are due to the following three causes:

- Voltage drop due to the resistance of the winding, IR.
- Voltage drop due to the leakage reactance of the winding, IX_l.
- Voltage variation due to the armature reaction effect, IX_a.

14. What is meant by armature reaction in Alternators?

The effect of armature flux on the flux produced by the field ampere turns is called as armature reaction.

15. What do you mean by synchronous reactance?

Synchronous reactance $X_s = (X_l + Xa)$

The value of leakage reactance X_l is constant for a machine based on its construction. X_l depends on saturating condition of the machine. Xa , which represent the armature reaction effect between two synchronously acting magnetic fields. The sum of leakage flux and armature reaction reactance makes the total reactance X_S to be called synchronous reactance.

16. What is meant by synchronous impedance of an Alternator?

The complex addition of resistance, R and synchronous reactance , jXs can be represented together by a single complex impedance Zs called synchronous impedance.

In complex form Zs = (R + jXs)

In polar form $Zs = |Zs| \angle\theta$

Where $|Zs| = \sqrt{R^2 + X_s^2}$ and $\theta = \tan^{-1}(Xs/R)$.

17. What is meant by load angle of an Alternator?

The phase angle introduced between the induced emf phasor, E and terminal voltage phasor (V), during the load condition of an Alternator is called load angle.

18. Upon what factors does the load angle depend?

The magnitude of load angle δ increases with increase in load. Further the load angle is positive during generator operation and negative during motor operation.

19. Define the term voltage regulation of Alternator. (Nov/Dec 2013) (May2017)

The voltage regulation of an Alternator is defined as the change in terminal voltage from no-load to load condition expressed as a fraction or percentage of terminal voltage at load condition; the speed and excitation conditions remaining same.

20. What is the necessity for predetermination of voltage regulation?

Most of the Alternators are manufactured with large power rating , hundreds of kW or MW, and also with large voltage rating up to 33kV. For Alternators of such power and voltage ratings conduction of load test is not possible. Hence other indirect methods of testing are used and then voltage regulation can be predetermined at any desired load currents and power factors.

21. Name the various methods for predetermining the voltage regulation of 3-phase Alternator.

The following are the three methods which are used to predetermine the voltage regulation of smooth cylindrical type Alternators

- Synchronous impedance / EMF method
- Ampere-turn / MMF method
- Potier / ZPF method

- ASA method

22. What are the advantages and disadvantages of estimating the voltage regulation of an Alternator by EMF method?

Advantages:

- Simple no load tests (for obtaining OCC and SCC) are to be conducted
- Calculation procedure is much simpler

Disadvantages:

- The value of voltage regulation obtained by this method is always higher than the actual value

23. Why is the synchronous impedance method of estimating voltage regulation considered as pessimistic method?

Compared to other methods, the value of voltage regulation obtained by the synchronous impedance method is always higher than the actual value and therefore this method is called the pessimistic method.

24. In what way does the ampere-turn method differ from synchronous impedance method?

The ampere-turn /MMF method is the converse of the EMF method in the sense that instead of having the phasor addition of various voltage drops/EMFs, here the phasor addition of MMF required for the voltage drops are carried out whiuch more accurate compared to EMF method. Further the effect of saturation is also taken care in this method.

25. Why is the MMF method of estimating the voltage regulation considered as the optimistic method?

Compared to the EMF method, MMF method, involves more number of complex calculation steps. Further the OCC is referred twice and SCC is referred once while predetermining the voltage regulation for each load condition. Reference of OCC takes care of saturation effect. As this method require more effort, the final result is very close to the actual value. Hence this method is called optimistic method.

26. State the condition to be satisfied before connecting two alternators in parallel. (Nov2016)

The following are the three conditions to be satisfied by synchronizing the additional alternator with the existing one or the common bus-bars.

- The terminal voltage magnitude of the incoming Alternator must be made equal to the existing Alternator or the bus-bar voltage magnitude.
- The phase sequence of the incoming Alternator voltage must be similar to the bus-bar voltage.
- The frequency of the incoming Alternator voltage must be the same as the bus-bar voltage.

27. How do the synchronizing lamps indicate the correctness of phase sequence between existing and incoming Alternators?

The correctness of the phase sequence can be checked by looking at the three sets of lamps connected across the 3-pole of the synchronizing switch. If the lamps grow bright and dark in unison it is an indication of the correctness of the phase sequence. If on the other hand, ie. If phase sequence is not correct they become bright and dark one after the other, then connections of any two machine terminals have to be interchanged after shutting down the machine.

28. What are the advantages and disadvantages of three dark lamps method of synchronizing?

Advantages:

- The synchronous switch using lamps is inexpensive
- Checking for correctness of the phase sequence can be obtained in a simple manner which is essential especially when the Alternator is connected for the first time or for fresh operation after disconnection

Disadvantages:

- The rate of flickering of the lamps only indicates the frequency difference between the bus-bar and the incoming Alternator. The frequency of the incoming Alternator in relation to the bus-bar frequency is not available.

29. How synchronoscope is used for synchronizing Alternators?

Synchronoscope can be used for permanently connected Alternators where the correctness of phase sequence is already checked by other means. Synchronoscope is capable of rotating in both directions. The rate of rotation of the pointer indicates the amount of frequency difference between the Alternators. The direction of rotation indicates whether incoming Alternator frequency is higher or lower than the existing Alternator. The TPST synchronizing switch is closed to synchronize the incoming Alternator when the pointer faces the top thick line marking.

30. Why synchronous generators are to be constructed with more synchronous reactance and negligible resistance?

The presence of more resistance in the Synchronous generators will resist or oppose their synchronous operation. More reactance in the generators can cause good reaction between the two and help the generators to remain in synchronism in spite of any disturbance occurring in any one of the generators.

31. List the factors that affect the load sharing in parallel operating generators?

The total active and reactive power delivered to the load, connected across the common bus-bars, are shared among Synchronous generators, operating in parallel, based on the following three factors

- Prime-mover characteristic/input
- Excitation level and
- Percentage synchronous impedance and its R/X ratio

32. How does the change in prime mover input affect the load sharing?

An increase in prime-mover input to a particular generator causes the active power shared by it to increase and a corresponding decrease in active-power shared by other generators. The change in reactive power sharing is less appreciable. The frequency of the bus-bar voltage will also subjected to slight increase in value.

33. How does change in excitation affects the load sharing?

The decrease in excitation in one generator causes the reactive power shared by it to decrease and a corresponding increase in reactive-power shared by other generators. The change in active-power sharing is less appreciable. There will be a slight decrease in terminal voltage magnitude also.

34. What is meant by infinite bus-bars?

The source or supply lines with non-variable voltage and frequency are called infinite bus-bars. The source lines are said to have zero source impedance and infinite rotational inertia.

35. How does increase in excitation of the Alternator connected to infinite bus-bars affect the operation?

Increase in excitation level of the synchronous generator will effectively increase the reactive component of the current supplied by the generator and hence the active power delivered.

36. What is meant by floating when the synchronous motor is connected to an infinite bus?

For starting a synchronous motor, a D.C motor is mechanically coupled with it. The D.C motor is started and its speed is adjusted to a value near about the syn speed of the synchronous motor. The excitation is gradually increased. The synchronous machine is now working as an alternator. The excitation is increased till the EMF induced is equal to the A.C bus bar voltage. If it is now synchronized with A.C supply, we will say the machine is 'floating' on the bus bar. The alternator will neither supply power nor take power from the bus bars.

37. What steps are to be taken before disconnecting one Alternator from parallel operation?

The following steps are to be taken before disconnecting one Alternator from parallel operation

- The prime-mover input of the outgoing generator has to be decreased and that of other generators has to be increased and by this the entire active-power delivered by the outgoing generator is transferred to other generators.
- The excitation of the outgoing generator has to be decreased and that of other generators have to be increased and by this the entire reactive-power delivered by the outgoing generator is transferred to other generators.
- After ensuring the current delivered by the outgoing generator is zero, it has to be disconnected from parallel operation.

38. Explain "phase Spread" in the armature winding.

In order to obtain the better-wave shape the coil are not concentrated or bunched in one slot, but are distributed in a number of slots to form polar groups under each pole. This is called phase spread. The winding so obtained is known as distributed winding.

39. What is an exciter?

The field windings of an alternator are excited by means of direct current from some external source. For this purpose D.C generator is used. This D.C generator is called as exciter.

40. What is a turbo-alternator?

Turbo-alternators are high-speed alternators. Therefore smooth cylindrical type rotor is used. To reduce the peripheral velocity, the diameter of the rotor is reduced and axial length is increased two or four poles are normally adopted for this type of alternators. Steam turbines are used as prime mover.

41. Why are the large capacity alternators made of revolving field type?

i. Rotating field is comparatively light and can run with high speed:
ii. It is easier to insulate stationary armature winding for very high voltage.
iii. Load circuit can be connected directly with the fixed terminals for the stator without passing through slip rings and brushes
iv. Only two slip rings are required to give D.C supply to the field system. This voltage is 110V or 220V and hence the slip rings can be easily insulated.

42. What is meant by armature reaction. (Nov/Dec 2013)

The load currents flowing in the stator winding usually generate a magnetic field which opposes the magnetic field generated by the excitation (field) winding, reducing the total airgap field and the terminal voltage. In order to counteract this reaction effect from the stator currents, the field current has to be adjusted (usually increased).

43. Why is the field system of an alternator made as a rotor? (Apirl/May 2012)

Number of brush, voltage drop across the brush, number of phases of windings in rotor and weight of rotor are reduced.

44. What is synchronizing power of an alternator? (Apirl/May 2012)

When two alternators are operated parallel after synchronism, suppose due to change in input parameter of second alternator it act as motor, first alternator supplies power to second alternator. That power is called as synchronous power.

PART –B

1. Find the no load phase and line voltages of a star connected 3 phase, 6 pole alternator which runs at 1200 Rpm, having flux per pole of 0.1wb sinusoidally distributed. It's stator has 54 slots having double layer winding. Each coil has 8 turns and the coil is chorded by 1 slot.
2. A 3300V, 3phase star connected alternator has a full load current of 100A. On short circuit a field current of 5A was necessary to produce full load current. The emf on open circuit for the same excitation was 900V. The armature resistance was 0.8 Ω/phase. Determine the full load voltage regulation for (1)0.8pf lagging (2)0.8pf leading. (Dec 2015)
3. A three phase 16 pole alternator has a star connected winding with 144 slots and 10 conductors per slot. The flux per pole 0.04wb and is sinusoidally distributed. The speed is 375 rpm. Find the frequency, phase emf and line emf. The coil span is 160^0 electrical.
4. Describe the principle and construction of slow speed operation generator with neat diagram.(Nov 2012) (May 2014) (Dec 2016) (May2018)
5. Derive the emf equation of alternator. (Nov/Dec 2011)& (Nov/Dec 2012) &(Nov/Dec 2013) (May 2014) (Dec 2015) (Dec 2016)(Nov2017)
6. What are the methods of determining regulation of alternator? Discuss each briefly. (May 2014)
7. Explain the procedure for POTIER method to calculate voltage regulation of alternator. (April/May 2012) (May2017) (May2018)
8. For a salient pole synchronous machine, prove the d-axis synchronous reactance X_d, can be obtained from its OCC and SCC. Neglect armature resistance.
9. Explain the condition for parallel operation of 3 phase alternator with neat diagram. (Nov/Dec 2012)
10. Explain about the various methods of Synchronization. (April/May 2012) (Nov2017)
11. Explain how will you determine the d and q axis reactance of a synchronous machine in your laboratory. (Nov/Dec 2011), (May 2014) (May 2014) (Nov2017)
12. For the salient synchronous machine, derive the expression for power developed as a function of load angle. (Nov/Dec 2011)
13. A four pole alternator has an armature with 25 slots and 8 conductors per slot and rotates at 1500 rpm and the flux per pole is 0.05Wb. Calculate the emf generated, if winding factor is 0.96 and all the conductors are in series. (Nov/Dec 2012).
14. Explain the EMF method of determining the regulation of an alternator. (Nov/Dec 2012)
15. Explain the phenomena of armature reaction in alternator for different load power factors. (April/May 2012) (Dec 2015) (May 2016)
16. What is synchronizing power of an alternator? Derive an expression for the synchronizing power between the two alternators connected in parallel. (April/May 2012)
17. List the methods used to predetermine the Voltage Regulation of Synchronous machine and explain the M.M.F Method. (Nov/Dec 2013) (Dec 2016) (Nov2017)

UNIT II
SYNCHRONOUS MOTOR
PART A

1. **Name the methods of starting a synchronous motors**
   - By an extra 3 phase induction motor
   - By providing damper winding in pole shoes
   - By operating the pilot exciter as a dc motor
2. **What is the effect on speed if the load is increased on a 3 phase synchronous motor?**
   The speed of operation remains constant from no load to maximum load if the motor operated constant frequency supply.
3. **Why a synchronous motor is called as constant speed motor? (April/May 2012)**
   Synchronous motor work on the principle of force developed due to the magnetic attraction established between the rotating magnetic field and the main pole feed. Since the speed of rotating magnetic field is directly proportional to frequency the motor operates at constant speed.
4. **What is the phasor relation between induced emf and terminal voltage of a 3 phase synchronous motor?**
   The rotating magnetic field is initially established by the prime source of supply V. The main field then causes an emf (e) to get induced in the 3 phase winding. Hence when the machine operates as a synchronous motor the emf phasor always lags the terminal voltage phasor by the load/torque angle δ.
5. **What are V and inverted V curves of synchronous motor ? (Nov/Dec 2011) (May2017)**
   The variation of magnitude of line current with respect to the field current is called V curve. The variation of power factor with respect to the field current is called inverted V curve.
6. **What happens when the field current of a synchronous motor is increased beyond the normal value at constant input?**
   Increase in emf causes the motor to have reactive current in the leading direction. The additional leading reactive current causes the magnitude of line current, accompanied by the decrease in power factor.
7. **Distinguish between synchronous phase modifier and synchronous condenser**
   A synchronous motor used to change the power factor or power factor in the supply lines is called synchronous phase modifier. A synchronous motor operated at no load with over excitation condition to draw large leading reactive current and power is called a synchronous condenser.

8. **How the synchronous motor can be used as synchronous condenser? (Nov/Dec 2011)& (Nov/Dec 2012) (May2017) (May2018)**
   Synchronous motor is operated on over excitation so as to draw leading reactive current and power from the supply lines. This compensates the lagging current and power requirement of the load making the system power factor to become unity. The motor does the job of capacitors and hence called as synchronous condenser.
9. **Mention the methods of starting of 3-phase synchronous motor.**
   i- A D.C motor coupled to the synchronous motor shaft.
   ii- A small induction motor coupled to its shaft
   iii.Using damper windings as a squirrel cage induction motor.
10. **What is meant by hunting of synchronous motor? (April/May 2012)& (Nov/Dec 2013)(Nov2016)**
    When the load applied to the synchronous motor is suddenly increased or decreased, the rotor oscillates about its synchronous position with respect to the stator field. This action is called hunting.
11. **Write important differences between a 3-phase synchronous motor and a 3-phase induction motor.**
    i. Synchronous motor is a constant speed motor where as induction motor speed will decrease on load.
    ii. Synchronous motor requires A.C and D.C supplies where as induction motor requires only A.C supply.
    iii. Synchronous motor can be worked under various power factors such as lagging, leading and unity. But induction motor can be run with lagging power factor only.
12. **What could be the reasons if a 3-phase synchronous motor fails to start?**
    It is usually due to the following reasons
    i. Voltage may be too low.
    ii. Too much starting toad.
    iii. Open circuit in one phase or short circuit.
    iv. Field excitation may be excessive.

13. **How does a change of excitation affect its power factor? (May2018)**

When the excitation is reduced, the motor draws a lagging current and when the excitation is increased, the armature current is leading the applied voltage. It may also happen for some value of excitation, that current may be in phase with the voltage i.e. power factor is unity.

14. **What is phase swinging?**

Phase swinging is otherwise called as hunting. When the load on the synchronous motor is varying or the supply frequency is pulsating the speed of the machine will fluctuate causing vibration on the rotor, which is called hunting or phase swinging.

15. **What is meant by pull out torque?**

When the load on the motor is increased, the load angle is also increased, i.e. the rotor goes on progressively falling back in phase and draws more current. If we increase the load further, then the motor pulls out of synchronism and stops. The torque developed at pull out point is called pull out torque.

16. **Under which condition a synchronous motor will fail to pull in to step?**

   i. No field excitation.
   ii. Excessive load.
   iii. Excessive load inertia.

17. **How will you reverse the direction of rotation of a 3-phase synchronous motor?**

By Inter changing two phases of the 3-phase supply connections the direction of rotation can be reversed.

18. **Write the applications of synchronous motor.**

   i. Used for power factor improvement in sub-stations and in Industries.
   ii. Used in industries for power applications-
   iii. Used for constant speed drives such as motor -generator set, pumps and compressors.

19. **Give some merits and demerits of synchronous motor**

Merits

   i. This motor runs at constant speed (synchronous spaed) even at full load.
   ii. Can be operated with leading power factor, for power factor improvement.

Demerits

   i. Two sources of supply are necessary
   ii. Since damper-winding resistance is low, it take large currents, from supply mains.

20. **Why a synchronous motor is a constant speed motor?**

It runs always with a constant speed called synchronous speed N =120 f/P. where f is the supply frequency and P is the no- of poles.

21. **How the synchronous motor is made self-starting?**

By providing damper windings in the pole face's, it will start and run like a squirrel cage induction motor.

22 **State the characteristic features of synchronous motor.**

a. the motor is not inherently self starting

b. The speed of operation is always in synchronous with the supply frequency irrespective of load conditions

c. The motor is capable of operating at any power factor.

23. **In what way synchronous motor is different from other motors?**

All dc and ac motors work on the same principle. Synchronous motor operates due to magnetic locking taking place between stator and rotor magnetic fields.

24. **Why a 3-phase synchronous motor will always run at synchronous speed?**

Because of the magnetic coupling between the stator poles and rotor poles the motor runs exactly at synchronous speed.

25.**What are the uses of damper winding in synchronous motor?) (Nov/Dec 2013) (Nov2016) (May2017)**

1.Starting of synchronous motor

2.Reduce the Oscillations

26.Explain "phase Spread" in the armature winding.

In order to obtain the better-wave shape the coil are not concentrated or bunched in one slot, but are distributed in a number of slots to form polar groups under each pole. This is called phase spread. The winding so obtained is known as distributed winding.

27. What is an exciter?

The field windings of an alternator are excited by means of direct current from some external source. For this purpose D.C generator is used. This D.C generator is called as exciter.

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30.What happens when the field current of a synchronous motor is increased beyond the normal value at constant input?

Increase in emf causes the motor to have reactive current in the leading direction. The additional leading reactive current causes the magnitude of line current, accompanied by the decrease in power factor.

PART-B

1. Draw the phasor diagram of a synchronous motor.
2. Explain the significance of V and inverted V curves. (Nov/Dec 2013)
3. Discuss the following (i) Constant excitation circle.(ii) Constant power circle. (Nov 2014) (Nov2017) (May2018)
4. Derive the mechanical power developed per phase of a synchronous motor.
5. A 5kW,3 phase Y-connected 50 Hz,440 V, cylindrical rotor synchronous motor operates at rated condition with 0.8 pf leading. The motor efficiency excluding field and stator losses is 95% and X_s=2.5 Ω. Calculate (i)Mechanical power developed (ii)armature current (iii)back emf (iv)power angle (v)maximum or pull out torque of the motor.
6. The input to an 11000 V, 3 phase star connected synchronous motor is 60 A. the effective resistance and synchronous reactance per phase are respectively 1Ω and 30 Ω. Find(i) The power supplied to the motor (ii)stator copper loss/phase (iii) Induced emf for a power factor of 0.8 leading
7. Explain V-curves and inverted V-curves. (Nov/Dec 2011)& (Nov/Dec 2012)& (Nov/Dec 2013) (Nov 2014) (Nov 2015) (May 2016) (Nov 2016) (May2017)
8. Explain the various starting methods of a synchronous motor. (Nov/Dec 2012)) (Nov 2014) (Nov 2015) (May 2016) (Nov 2016) (Nov2017)
9. Explain effect of changing field current excitation at constant load. (i)Under excitation (ii)Normal excitation (iii)Over excitation(Nov/Dec 2011)& (April/May2012) (May 2014) (Nov 2015) (May 2016)
10. A synchronous motor having 40% reactance and negligible resistance is to be operated at rated voltage at UPF,0.8pf lag and 0.8pf lead. What are the values of induced emf.
11. A 75 kW, 400V, 4 pole, 3 phase, star connected synchronous motor has a resistance and synchronous reactance per phase of 0.04Ω and 0.4 Ω respectively. Compute for full load 0.8pf lead the open circuit emf per phase and gross mechanical power developed. Assume an efficiency of 92.5%. (May 2014)
12. A 2000V, 3 phase, 4 pole, star connected synchronous motor runs at 1500rpm. The excitation is constant and corresponding to an open circuit voltage of 2000V. The resistance is negligible in comparison with synchronous reactance of 3.5Ω /ph. For an armature current of 200A.Determine (i) power factor (ii) power input (iii) torque developed.
13. Derive an expression for the maximum torque developed per phase of a synchronous motor.(April/May 2012) (May2017)
14. Explain how synchronous motor can be used as a synchronous condenser. Draw the phasor diagram. (April/May 2012) (Nov2017)
15. Discribe the principle of operation of synchronous motor. (Nov2017)

UNIT III
THREE PHASE INDUCTION MOTOR
PART A

1. State the principle of 3 phase IM?

While starting, rotor conductors are stationary and they cut the revolving magnetic field and so an emf is induced in them by electromagnetic induction. This induced emf produces a current if the circuit is closed. This current opposes the cause by Lenz's law and hence the rotor starts revolving in the same direction as that of the magnetic field.

2. Why an induction motor is called a 'rotating transformer'?

The rotor receives electric power in exactly the same way as the secondary of a two-winding transformer receiving its power from the primary. That is why an induction motor can be called as a rotating transformer i.e. one in which primary winding is stationary but the secondary is tree to rotate.

3. Why an induction motor will never run at its synchronous speed? (May2018)

If the rotor runs at synchronous speed, then there would be no relative speed between the two; hence no rotor EMF, no rotor current and so no rotor torque to maintain rotation. That is why the rotor runs at a speed, which is always less than syn. speed.

4. State the advantages of skewing? (Nov/Dec 2011) (Nov2016) (May2017)

- It reduces humming and hence quite running of motor is achieved.
- It reduces magnetic locking of the stator and rotor.

5. State the condition at which the starting torque developed in a slip-ring induction motor is maximum.

$R_2=X_2$

6. What are the effects of increasing rotor resistance on starting current and starting torque?

- The additional external resistance reduces the rotor current and hence the current drawn from the supply.
- It improves the starting torque developed by improving the power factor in high proportion to the decrease in rotor current.

7. What is slip of an induction motor? (Nov/Dec 2011)& (Nov/Dec 2012))& (Nov/Dec 2013)

The slip speed is defined as the ratio of relative speed to synchronous speed is expressed as

% slip S=(Ns-N)/Ns*100

8. How the magnitude of rotor emf is related to the slip in an IM?

Rotor circuit emf per phase $E_{2r}=SE_2$

9. State the condition at which the torque developed in a 3 phase induction motor is maximum.

$R_2=SX_2$

10. What are the advantages of slip-ring IM over cage IM?

(i) Rotor circuit is accessible for external connection.
(ii) By adding external resistance to the rotor circuit the starting current is reduced with the added advantage of improving starting torque.
(iii) Additional speed control methods can be employed with the accessibility in the rotor circuit.

11. What are the losses occurring in an IM and on what factors do they depend?

Magnetic losses $W_{i,}$ Electrical losses W_{cu} and Mechanical losses W_m

For IM operating in normal condition (with constant voltage and frequency) magnetic and mechanical losses remain constant whereas electrical losses vary in square proportion to the current.

12. What care should be taken at the time of construction to reduce eddy current losses in I M?

Make the resistance of the core body as large as possible. This is achieved by laminating the stator core, stacked and riveted at right angles to the path of eddy current. The laminations are insulated from each other by thin coat of varnish.

13. Why is there not appreciable magnetic losses in the rotor core of Induction motors?

Although the rotor core is also subjected to magnetic flux reversals and since the frequency of flux reversals in the rotor, $f_r = Sf_s$, is very small, the iron loss incurred in the rotor core is negligibly small.

14. What is meant by synchronous watts?

The torque developed in an induction motor is proportional to rotor input. By defining a new unit of torque (instead of the force at radius unit) we can say that the rotor torque equals rotor input. The new unit is synchronous watts. Synchronous wattage of an induction motor equals the power transferred across the air-gap to the rotor.

15. How does the shaft torque differ from the torque developed in 3-phase Induction motor?

The mechanical power developed Pd causes the rotor to rotate at a speed Nr due to the torque Td developed in the rotor. Therefore, equation for Pr can be written as

$$P_d = \frac{2\pi N_r T_d}{60}$$

The remaining power, after the mechanical losses Wm are met with, available in the shaft as mechanical power output Po.

Po = Pd – Wm

The mechanical power output Po, which is less than Pd is available in the shaft running at a speed of Nr and with a shaft torque T. Therefore the shaft torque (T) is slightly less than the torque developed Td,

$$P_d = \frac{2\pi N_r T_d}{60}$$

$W_m = P_d – P_0 = [2\pi N_r(Td – T)] / 60$

16. Name the tests to be conducted for predetermining the performance of 3-phase induction machine.

(a) No load test

(b) Blocked rotor test

17. What are the information's obtained from no-load test in a 3-phase I M?

(i) No –load input current per phase, Io

(ii) No load power factor and hence no load phase angle

(iii) Iron and mechanical losses together

(iv) Elements of equivalent circuit shunt branch

18. What are the information's obtained from blocked rotor test in a 3-phase I M?

(i)Blocked rotor input current per phase at normal voltage

(ii) Blocked rotor power factor and hence phase angle

(iii) Total resistance and leakage reactance per phase of the motor as referred to the stator.

19. What is circle diagram of an IM?

When an I M operates on constant voltage and constant frequency source, the loci of stator current phasor is found to fall on a circle. This circle diagram is used to predict the performance of the machine at different loading conditions as well as mode of operation.

20. What are the advantages and disadvantages of circle diagram method of predetermining the performance of 3 –phase IM?

The prediction can be carried out when any of the following information is available The input line current., the input power factor, The active power input, The reactive power input, The apparent power input, The output power , The slip of operation, The torque developed, The equivalent rotor current per phase, Maximum output power, Maximum torque developed. The only disadvantage is, being a geometrical solution; errors made during measurements will affect the accuracy of the result.

21. What are the advantages and disadvantages of direct load test for 3 –phase I M?

Advantages

- Direct measurement of input and output parameters yield accurate results
- Aside from the usual performance other performances like mechanical vibration, noise etc can be studied.
- By operating the motor at full load for a continuous period, the final steady temperature can be measured.

Disadvantages

- Testing involves large amount of power and the input energy and the entire energy delivered is wasted.

22. What is an induction generator? (April/May 2012)

An induction generator does not differ in its construction from an induction motor. Whether the induction, machine acts as generator or motor depends solely upon its slip. Below synchronous speed it can operate only as motor, above synchronous speed it operates as generator and is now called as induction generator.

23. Describe a method to make an induction motor a two-speed motor.

The change in number of poles is achieved by having two entirely independent stator windings in the same slots. Each winding gives a different number of poles and hence different synchronous speed.

24. What do you mean by slip speed?

The difference between the synchronous speed and the rotor speed N is called as slip speed. The rotor speed will be always less than synchronous speed.

25. Explain why an induction motor, at no-load, operates at very low power factor. (May2018)

The current drawn by an induction motor running at no load is largely a magnetizing current. So, no-load current lags behind the applied voltage by a large angle. Therefore the power factor of a lightly loaded induction motor is very low.

26. What is cogging of induction motor?

When the number of teeth in stator and rotor are equal, the stator and rotor teeth have a tendency to align themselves exactly to minimum reluctance position. In such case the rotor may refuse to accelerate. This phenomenon is called "magnetic locking, or cogging.

27. What are the advantages of double squirrel cage induction motor. (Nov/Dec 2012) (May2017)

- Improves the starting torque
- Low I^2R loss under running conditions and hence high efficiency.

28. How the direction of rotation of a three phase induction motor can be reversed? (April/May 2012) (Nov2016)

The direction of rotation of three phase induction motor can be changed by interchanging any two terminal of input supply (R&Y,R&B, etc.,). The direction of the synchronously rotating field reverses and hence the direction of rotor reverses.

29. Describe a method to make an induction motor a two-speed motor.

The change in number of poles is achieved by having two entirely independent stator windings in the same slots. Each winding gives a different number of poles and hence different synchronous speed.

30. What do you mean by slip speed?

The difference between the synchronous speed and the rotor speed N is called as slip speed. The rotor speed will be always less than synchronous speed.

PART B

1. Explain the construction and working of three phase induction motor. (Nov/Dec 2011), (April/May 2012)&(Nov/Dec 2012) &(Nov/Dec 2013) (Nov 2014) (Nov 2015) (Nov2017) (May2018)
2. Explain the power flow diagram and torque slip characteristics of induction motor.
3. Derive the torque equation of a three phase induction motor. (Nov/Dec 2013) (Nov2017)
4. Develop an equivalent circuit for three phase induction motor. State the difference between exact and approximate equivalent circuit. (Nov/Dec 2011) &(Nov/Dec 2012) .(Nov 2015) (May 2016) (Nov 2016) (May2018)
5. The power input to the rotor of a 3 phase, 50 HZ, 6 pole induction motor is 80 KW. The rotor emf makes 100 complete alternations per minute. Find (i)Slip (ii)Motor Speed (iii)Rotor copper loss per phase (iv)Rotor resistance per phase if rotor current is 65A.
6. Derive the equation for torque developed by an induction motor .Draw a typical torque – slip curve and deduce the condition for maximum torque. (May 2016) (Nov2017)
7. A 3300V,10 pole ,50HZ three phase star connected induction motor has slip ring rotor resistance per phase=0.015Ω and standstill reactance per phase =0.25Ω .If the motor runs at 2.5 percent slip on full load ,find (i)Speed of the motor (ii) Slip at which the torque will be maximum. (iii)The ratio of maximum torque to full load torque. A 3 phase, 4 pole, 50 HZ induction motor is running at 1440 rpm. Determine the synchronous speed and slip.
8. Describe the no load and blocked rotor tests in a three phase induction motor.
9. A 100kW, 330V, 50Hz, 3 phase, star connected induction motor has a synchronous speed of 500 rpm. The full load slip is 1.8% and full load power factor 0.85. Stator copper loss is 2440W, iron loss is 3500W, rotational losses is 1200W. Calculate (i) rotor copper loss, (ii) the line current and (iii) the full load efficiency.
10. A 6 pole, 50Hz, 3 phase, induction motor running on full load develops a useful torque of 160Nm. When the rotor emf makes 120 complete cycle per minute. Calculate the shaft power input. If the mechanical torque lost in friction and that for core loss is 10 Nm, compute (i)The copper loss in the

rotor windings.(ii)The input of motor.The efficiency. The total stator loss is given to be 800W. (Nov/Dec 2011)

11. Explain the torque slip characteristics of 3 phase induction motor. (Nov/Dec 2011)& (Nov/Dec 2012) (Nov 2014) (Nov 2015) (Nov 2016) (May2017)
12. Explain the test required to be performed to obtain the data for the circle diagram. (April/May 2012)
13. Describe the principle and operation of synchronous induction motor.(Nov 2014)
14. Explain the construction of circle diagram of 3 phase induction motor. (May 2016) (May2017)

UNIT IV
STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR
PART A

1. What is the need of starter for induction motor? (April/May 2012) (Nov2016) (May2018)

The plain induction motor is similar in action to polyphase transformer with a short-circuited rotating secondary. Therefore, if normal supply voltage is applied to the stationary motor, then, as in case of a transformer, a very large initial current about 5-7 times full load current is drawn taken by the stator.

2. What is the magnitude of starting current & torque for induction motor?

Induction motors, when direct-switched take five to seven times the full load current and develop only 1.5 to 2.5 times their full- load torque.

3. What is the relationship between staring torque and full load torque of DOL Starter?

$T_{st} / T_f = (I_{sc}/I_f)^2 . s_f$

4.Name the different types of starters used for induction motor. (Nov/Dec 2013) (Nov2016)

- Primary resistor
- Autotransformer starter
- Star-delta starter
- Rotor rheostat

4. What are the advantages of primary resistance starter of induction motor?

(i) starting torque to full load torque is x^2 of that obtained with direct switching or across the line starting.

(ii) This method is useful for smooth starting of small machines only.

5. What are the advantages of autotransformer starter?

(i) reduced voltage is applied across the motor terminal.

(ii) There is a provision for no-voltage and over-load protection.

6. Brief the over –load protection of autotransformer starter.

When the load on the motor is more than the rated value the supply to motor will be cut off.

7. Give the relationship between starting current and full load current of autotransformer starter.

$I_2 = K. I_{sc}$ where K is transformation ratio.

8. How the induction motor is started using star-delta starter?

The motor is connected in star for starting and then for delta for normal running.

9.Give the relationship between starting torque and full load torque of induction motor.

$T_{st} / T_f = 1/3. a^2 . s_f$

10. How much time starting current is reduced in induction motor when it is connected in star?

The line current is reduced to $1/\sqrt{3}$ times of delta connected.

11. Give the relationship between starting torque of induction motor with autotransformer starter and star delta starter

Star delta switch is equivalent to an autotransformer of ratio 58% approximately.

12. How the starting current is reduced using rotor resistance starter. (Nov/Dec 2011)

The controlling resistance is in the form of a rheostat, connected in star. The resistance being gradually cut-out of the rotor circuit as the motor gathers speed. Increasing the rotor resistance, not only in the rotor current reduced at starting, but at the same time starting torque is also increased due to improvement in power factor.

13. **Mention the methods of speed control on stator side of induction motor. (Nov/Dec 2011)& (Nov/Dec 2012)**

- By changing the applied voltage
- By changing the applied frequency
- By changing the number of stator poles.

14. Mention the methods of speed control from rotor side of induction motor. (Nov/Dec 2011)& (Nov/Dec 2012)

- Rotor rheostat control.
- By operating two motors in concatenation or cascade.
- By injecting an e.m.f in the rotor circuit.

15. Why speed control by changing the applied voltage is simpler? Explain.

- A large change in voltage is required for a relatively small change in speed.
- This large change in voltage will result in a large change in the flux density thereby seriously disturbing the magnetic conditions of the motor.

16. What are the limitations of speed control of induction motor by changing the supply frequency?

This method could only be used in cases where the induction motor happens to be the only load on the generators.

17. What are the applications of speed control of induction motor by pole changing method?

- Elevator motors
- Traction motors
- Small motors driving machine tools.

18. How the speed control is achieved by changing the number of poles.

Synchronous speed of induction motor could also be changed by changing the number of stator poles. This change of number of poles is achieved by having two or more entirely independent stator windings in the same slots.

19. What are the limitations of rotor rheostat speed control of induction motor? (May2017)

- With increase in rotor resistance, I^2R losses also increase which decrease the operating efficiency of the motor. In fact, the loss is directly proportional to the reduction in the speed.
- Double dependence of speed, not only on R_2 but also on load as well.

20. Mention the three possible methods of speed control of cascaded connection of induction motor.

- Main motor may be run separately from the supply
- Auxiliary motor may be run separately from the mains.
- The combination may be connected in cumulative cascade.

21. How the tandem operation of induction motor start?

When the cascaded set is started, the voltage at frequency f is applied to the stator winding of main motor. An induced emf of the same frequency is produced in main motor (rotor) which is supplied to the auxiliary motor. Both the motors develop a forward torque. As the shaft speed rises, the rotor frequency of main motor falls and so does the synchronous speed of auxiliary motor. The set settles down to a stable sped when the shaft speed become equal to the speed of rotating field of Auxiliary motor

22. Brief the method of speed control by injecting emf in the rotor circuit.

The speed of an induction motor is controlled by injecting a voltage in the rotor circuit. It is necessary for the injected voltage to have the same frequency as the slips frequency

23. What are the advantages of slip power scheme? (May2017) (May2018)

Advantages

- Easier power control.
- Higher efficiency.

Disadvantage

- Reactive power consumption.
- Low power factor at reduced speed.

24. Mention types of slip power recovery schemes.

- Scherbius system.
- Kramer drive.

25. What is effect of increasing rotor resistance in starting current and torque. (Nov/Dec 2012)

Staring current can be reduce and starting can be increase by increasing the rotor resistance of an induction motor.

26. Why are most of the three phase induction motors constructed with delta connected stator winding? (April/May 2012)

Squirrel cage induction motor started with star to delta starter, therefore stators winding in delta connection.

28.What is meant by slip power recovery scheme? (Nov/Dec 2013)

Some amount of power is wasted in the rotor circuit .wasted power is recovered by using converter.

29. How the speed control is achieved by changing the number of poles.

Synchronous speed of induction motor could also be changed by changing the number of stator poles. This change of number of poles is achieved by having two or more entirely independent stator windings in the same slots.

30. What are the limitations of rotor rheostat speed control of induction motor?

- With increase in rotor resistance, I^2R losses also increase which decrease the operating efficiency of the motor. In fact, the loss is directly proportional to the reduction in the speed.
- Double dependence of speed, not only on R_2 but also on load as well.

PART B

1. With neat diagrams explains the working of any two types of starters used for squirrel cage type 3 phase induction motor. (Nov/Dec 2013) (Nov2017)
2. Discuss the various starting methods of induction motors. (April/May 2012) (May 2014)
3. Explain the different speed control methods of phase wound induction motor.
4. Explain the various schemes of starting squirrel cage induction motor. (Nov 2015) (Nov 2016) (May2018)
5. Explain the speed control of 3 phase squirrel cage induction motor by pole changing. (Nov2017)
6. Describe with a neat sketch, the principle and working of a star – delta starter and auto transformer starter. (Nov/Dec 2011)& (Nov/Dec 2012) (Nov 2014) (Nov2017)
7. Explain briefly the various speed control schemes of induction motors. (Nov 2014) (Nov 2015) (May 2016) (Nov 2016) (Nov2017) (May2018)
8. Explain in detail the slip power recovery scheme. (Nov/Dec 2011)&(Nov/Dec 2012)& (Nov/Dec 2013) (May 2014) (Nov 2014) (Nov 2015) (May2016) (May2017) (Nov2017)
9. Explain the various techniques of speed control of induction motor from rotor side control. (April/May 2012)
10. Explain the cascade operation of induction motors to obtain variable speed.
11. Describe a starter suitable for a three phase slip ring induction motor. (April/May 2012) (Nov 2015) (May 2016)
12. Explain the speed control of -3 phase wound rotor induction motor by the rotor resistance method (Nov/Dec2013)

UNIT V
SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES
PART A

1. **Name the two windings of a single-phase induction motor.**
   i. Running winding (main winding)
   ii. Starting winding (auxiliary winding)

1. **What are the various methods available for making a single-phase motor self-starting? (Nov/Dec 2012) (May2018)**
   i. By splitting the single phase
   ii. By providing shading coil in the poles
   iii. Repulsion start method.
   iv. Capacitor start capacitor run.

3. What could be the reasons if a split-phase motor runs too slow?

Any one of the following factors could be responsible.

(i) Short-circuited or open winding in field circuit.
(ii) Over load.
(iii) Grounded starting and running winding.
(iv) Wrong supply voltage and frequency.

4. What could be the reasons that a split-phase motor fails to start and hums loudly?

It could be due to the starting winding being open or grounded or burnt out.

5. What is the main basic difference between the principle of operation of a 3-phase and single -phase induction motors?

When three-phase supply is given to 3-phase induction motor, a rotating magnetic field is produced and the rotor-starts rotating. But when single-phase supply is given to single-phase motor only a pulsating flux is produced. So motor is not self-starting. Therefore to make it self-starting split-phase arrangement is made by providing an auxiliary winding.

6. Give the main difference in construction of an A.C series motor and a D.C series motor.

i. The entire iron structure of the field cores and yoke are laminated to reduce the eddy current loss.
ii. Number of turns in the field winding is reduced to have large reactance and higher power factor.
iii. A.C series motors are provided with commutating poles.

7. Differentiate between "Capacitor start" and "Capacitor start capacitor run" induction motors.

In "capacity, start" motor capacitor is connected in series with the starting winding. But it will be disconnected from the supply when the motor picks up its speed. But in capacitor start, capacitor-run motor the above starting winding and capacitor are not disconnected, but always connected in the supply. So it has high starting and running torque.

8. Why single-phase induction motor has low power factor?

The current through the running winding lags behind the supply voltage by a very large angle. Therefore power factor is very low.

9. Why a capacitor run type motor is considered as superior one?

i. It has high starting and running torques.
ii. Current drawn is less because of higher power factor
iii. It can be started with some load.

10. What type of single-phase induction motors is employed in high-speed fractional KW applications?

Single phase A.C series motor.

11. How can a universal motor rotation be reversed?

i. The direction of rotation of the concentrated-pole (or salient-pole) type universal motor may be reversed by reversing the flow of current through either the armature or field windings.

ii The direction of rotation of the distributed field compensating type universal motor may be reversed by interchanging either the armature or field leads and shifting the brushes against the direction in which the motor win rotate.

12. What is the function of centrifugal switch in a single phase - induction motor? (April/May 2012)

Its function is to automatically disconnect the starting winding from the supply when the motor has reached 70 to 80 percent of its full speed is reached.

13. Explain why a single-phase induction motor is not self-starting? (May2017)

When the motor is fed from a single-phase supply, its stator winding produces an alternating or pulsating flux, which develops no torque. That is why a single-phase motor is not self-starting.

14. State some applications of universal motor.

Used for sewing machines, table fans, vacuum cleaners, hair driers, blowers and kitchen appliances etc.

15. State the advantages of capacitor-run over capacitor start motor.

i. Running torque is more.
ii. Power factor during running is more, thereby line current is reduced.

16. What is a universal motor?

A universal motor is defined as a motor, which may be, operated either on direct current or single phase A.C supply, at approximately, the same speed and output.

17. Why should a motor be named as universal motor?

The available supply in the universe is both A.C and D.C. So the rotor, which works on both A.C and D.C, is called universal motor.

18. What is the use of shading ring in a shaded pole motor?

The shading coil causes the flux in the shaded portion to lag behind the flux in UN shaded portion of pole. This gives in effect a rotation of flux across the pole (ace and under the influence of this moving flux a starting torque is developed.

19. Stare the advantages of using capacitor start motor over a resistance split phase motor. (April/May 2012)

i. The starting current of capacitor start motor is less than resistance split phase motor

ii. Starting torque of the capacitor motor is twice that of resistance start motor.

20. Give the names of three different types of single-phase induction motor

i. Split-phase motor
ii. Shaded pole motor
iii. Single phase series motor
iv. Repulsion motor
v. Reluctance motor

21. How will you change the direction of rotation of a split phase induction motor? (Nov2017)

By changing the direction of current either in the starting winding or in the running winding the direction of rotation can be changed.

22. What are the inherent characteristics of plain 1-phase Induction motor ?

A plain 1-phase Induction motor is not used in practice due to the following inherent characteristics

- A plain 1-phase Induction motor does not have any starting torque
- **However, if the rotor is initially given a starting torque, by some means, the motor can pick up its speed** in a direction at which the initial torque is given and deliver the required output.

23. Name the two different theories with which principle of 1-phase induction motors are explained.

The two different theories employed are

- Double revolving field theory
- Cross field theory

24. State double revolving field theory. (Nov/Dec 2013) (May2017)

Double revolving theory, formulated by Ferrari, states that a single pulsating magnetic field ϕ_m as its maximum value can be resolved into two rotating magnetic fields of $\phi_m/2$ as their magnitude rotating in opposite direction as synchronous speed proportional to the frequency of the pulsating field.

25. What type of motor is used for ceiling fan? (Nov/Dec 2011)

Singe phase induction motor.

26. State the application of shaded pole motor. (Nov/Dec 2011) (Nov2016)

- Low power household application because the motors have low starting torque and efficiency ratings
- Hair dryers, humidifiers and timing devices.

27. What is meant by single phasing? (Nov/Dec 2012)

Induction motor can operate in single phase supply is called as single phasing.

PART – B

1. Give the classification of single phase motors .Explain any two types of single phase induction motors (Nov/Dec 2013) (May 2016) (May2018)
2. Explain the double field revolving theory for operation of single phase induction motor. (April/May 2012) &(Nov/Dec 2012) (May 2014) (Nov 2015) (Nov 2016) (May2017) (Nov2017)
3. Explain the operation of shaded pole induction motor with diagram. (April2012) &(Nov15) (Nov2017)
4. Develop equivalent circuit of a single phase induction motor ignoring core losses. (May 2014) (Nov 2014) (Nov 2015)
5. Explain the working principle of single phase induction motor. Mention its four applications.
6. What is the principle and working of hysteresis motor and AC series motor? Explain briefly.(Nov 2011)& (Nov 2012) (May 2014) (Nov 2014) (Nov 2015) (May2016) (Nov2016) (May2017) (May2018)
7. Explain the principle of operation and applications of reluctance motor. (April/May 2012)
8. Explain the principle of operation and applications of repulsion motor and hysteresis motor (April/May 2012) (Nov 2015) (Nov2017) (May2018)
9. Explain about no load and blocked rotor test of single phase induction motor. (Nov 2014) (Nov2017)
10. Explain with a neat diagram the following types of single phase induction

motor. (a). Split phase induction run motor.

11. (b).Capacitor start induction run motor and also draw the slip torque characteristics.(Nov/Dec 2013) (May 2016)
12. Describe the working principle of any one type of stepper motor. (Nov2017)

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Fifth Semester

Electrical and Electronics Engineering

EE 2302/EE 52/EE 1301/10133 EE 505 – ELECTRICAL MACHINES – II

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. State the causes of voltage drop in an alternator when loaded.
2. What is meant by armature reaction?
3. What is hunting?
4. What is synchronous condenser?
5. Define 'slip' of an induction motor.
6. What are the advantages of double squirrel cage induction motor?
7. What is the effect of increasing the rotor resistance on starting current and torque?
8. List out the methods of speed control of cage type 3Φ induction motor.
9. What is meant by single phasing?
10. Name the methods of starting single induction motors.

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) With neat sketch describe the construction and principle of operation of salient pole alternator. (6)

(ii) Derive the EMF equation of an alternator. (6)

(iii) A 4-pole alternator has an armature with 25 slots and 8 conductors per slot and rotates at 1500 rpm and the flux per pole is 0.05Wb. Calculate the e.m.f generated, If winding factor is 0.96 and all the conductors are in series. (4)

Or

(b) (i) Explain the EMF method of determining the regulation of an alternator. (8)

(ii) State and explain the conditions for parallel operation of Alternators. (8)

12. (a) (i) Describe in detail about the effect of load change on load angle and power factor of a 3Φ synchronous motor operating on infinite bus bar and constant excitation. (10)

(ii) Discus in detail how V curves is obtained for a synchronous motor. (6)

Or

(b) Describe the various methods of starting the synchronous motor. (16)

13. (a) (i) Deduce and discuss the equivalent circuit of 3Φ induction motor. (8)

(ii) Explain with neat diagram, the constructional features and working principle of a 3Φ induction motor. (8)

Or

(b) Sketch and explain the torque slip characteristics of the 3Φ cage and slip-ring induction motors. Show the stable region in the graph. (16)

14. (a) Why starters are necessary for starting 3Φ induction motors? What are the various types of starters? Explain star-delta type starter in detail. (16)

Or

(b) With neat diagram explain the slip power recovery scheme. (16)

15. (a) Explain the double field revolving theory for operation of single phase induction motor. (16)

Or

(b) Explain the following with neat diagram :

(i) Shaded pole induction motor. (8)

(ii) Hysteresis motor. (8)

Reg. No. :

Question Paper Code : 31401

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Fifth Semester

Electrical and Electronics Engineering

EE 2302/EE 52/EE 1301/10133 EE 505 – ELECTRICAL MACHINES – II

(Regulation 2008/2010)

(Common to PTEE 2302 Electrical Machines II for B.E. (Part-Time) Fourth Semester Electrical and Electronics Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by armature reaction in Alternator?
2. Define the term voltage regulation of Alternator.
3. What is meant by hunting of a synchronous motor?
4. What are the uses of damper winding in synchronous motor?
5. Why are the slots on the cage rotor of induction motor usually skewed?
6. Define slip of an induction motor.
7. What are the different methods of starting 3-phase induction motor?
8. What is meant by slip power recovery scheme?
9. What are inherent characteristics of plain 1-phase induction motor?
10. State the double revolving field theory.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive an expression for the emf induced in an Alternator. (8)

(ii) A 3-phase 16 pole alternator has star connected winding with 144 slots and 10 conductors per slot. The flux per pole is 0.04 wb and is distributed sinusoidally. The speed is 375 rpm. Find the frequency, phase emf, and line emf. The coil span is 120° electrical. (8)

Or

(b) List the methods used to pre determine the voltage regulation of synchronous machine and explain the MMF method. (16)

12. (a) The synchronous reactance per phase of a 3-phase, star connected 6600 V synchronous motor is 20Ω. For a certain load the input is 900 kW at normal voltage and the induced line emf is 8500 V. Determine the line current and power factor. (16)

Or

(b) (i) Explain V curves and inverted V curves of a synchronous motor. (8)

(ii) Draw and explain the equivalent circuit and phasor diagram of a cylindrical rotor synchronous motor operating at different power factors. (8)

13. (a) Draw the circle diagram of a 15 hp, 230 V, 50 Hz, 3-phase slip-ring induction motor with a star connected stator and rotor. The winding ratio is unity. The stator resistance is 0.42Ω/ phase and the rotor resistance is 0.3Ω/phase. The following are the test readings,

No load test: 230 V, 9A, p.f. = 0.2143

Blocked rotor test: 115 V, 45 A p.f. = 0.454

Find

(i) Starting torque

(ii) maximum torque

(iii) maximum power factor

(iv) slip for maximum torque

(v) maximum power output. (16)

Or

(b) (i) Describe the construction and principle of operation of a 3-phase induction with neat sketch. (10)

(ii) Derive the condition for maximum torque in 3-phase induction motor. (6)

14. (a) With neat diagrams, explain working of any two types of starter used for 3-phase squirrel cage induction motor. (16)

Or

(b) (i) Explain the speed control of 3-phase wound rotor induction motor by rotor resistance method. (8)

(ii) Explain in details the slip recovery scheme. (8)

15. (a) Explain with suitable diagram the working principle of split-phase and capacitor start induction motor. (8+8)

Or

(b) Discuss briefly the operation and characteristics of

(i) Repulsion motor (8)

(ii) AC series motor. (8)

Reg. No. | | | | | | | | | | | | |

Question Paper Code : 51441

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Fifth Semester

Electrical and Electronics Engineering

EE 2302/EE 52/EE 1301/10133 EE 505 — ELECTRICAL MACHINES — II

(Regulation 2008/2010)

(Common to PTEE 2302 Electrical Machines II for B.E. (Part–Time)
Fourth Semester Electrical and Electronics Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. How will you distinguish between the two types of large synchronous generator from their appearance?

2. What is meant by alternator on infinite bus- bars?

3. Name any two important characteristic of a 3 phase synchronous motor not found in 3 phase induction motor.

4. Give any two methods of starting a synchronous motor.

5. How do change in supply voltage and frequency affect the performance of a 3 phase induction motor?

6. The starting torque of a squirrel cage induction motor cannot be altered when the applied voltage is constant. Why?

7. Which is the cheapest method of starting a three phase induction motor?

8. What is meant by plugging?

9. How can the direction of a capacitor run motor be reversed?

10. Name the motor being used in ceiling fans.

PART B — (5 × 16 = 80 marks)

11. (a) A 3–phase, star –connected, 1000KVA, 11,000V alternator has rated current if 52.5A. The ac resistance of the winding per phase is 0.45 Ω. The test results are given below:

OC Test: field current = 12.5 A, voltage between lines = 422 V.

SC Test: field current = 12.5A, line current = 52.5 A

Determine the full load voltage regulation of the alternator

(i) 0.8 pf lagging and

(ii) 0.8 pf leading.

Or

(b) Describe a method of determining direct and quadrature axis reactance of salient pole alternator.

12. (a) Describe briefly the effect of varying excitation upon the armature current and power factor of a three phase synchronous motor when input power to the motor is maintained constant.

Or

(b) A 75 KW, 400 V, 4–pole, 3-phase, star-connected synchronous motor has a resistance and synchronous reactance per phase of 0.04 Ω and 0.4 Ω respectively. Compute for full load 0.8 pf lead the open–circuit emf per phase and gross mechanical power developed. Assume an efficiency of 92.5%

13. (a) (i) A 746 KW, 3-phase, 50 Hz, 16-pole induction motor has a rotor impedance of $(0.02 + j0.15)\,\Omega$ at standstill. Full load torque is obtained at 360 rpm. Calculate

(1) The ratio of maximum to full–load torque

(2) The speed at maximum torque and

(3) The rotor resistance to be added to get maximum starting torque. (12)

(ii) Sketch the torque slip characteristic of an induction motor working at rated voltage and frequency. (4)

Or

(b) A 15 KW, 400V, 50Hz, 3 phase star connected induction motor gave the following test results:

No load test: 400V, 9A, 1310W

Blocked rotor test: 200V, 50A, 7100W

Stator and rotor ohmic losses at standstill are assumed equal.

Draw the induction motor circle diagram and calculate

(i) Line current,

(ii) Power factor,

(iii) Slip

(iv) Torque and efficiency at full load.

14. (a) (i) Explain the method of starting of slip ring Induction motor. (8)

(ii) A three phase induction motor takes a starting current which is 5 times full-load current at normal voltage. Its full–load slip is 4 per cent. What auto–transformer ratio would enable the motor to be started with not more than twice the full load current drawn from the supply? What would be the starting torque under this condition? (8)

Or

(b) Explain speed control of 3 phase induction motor by slip power recovery scheme with neat sketches.

15. (a) Using double field revolving theory, explain why a single phase induction motor is not self-starting. Also Obtain the equivalent circuit of single phase induction motor with necessary equations.

Or

(b) Explain the construction and working of AC series motor and hysteresis motor in detail.

Reg. No. :

Question Paper Code : 91444

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Fifth Semester

Electrical and Electronics Engineering

EE 2302/EE 52/EE 1301/10133 EE 505 — ELECTRICAL MACHINES — II

(Regulation 2008/2010)

(Common to PTEE 2302/10133 EE 505 Electrical Machines II for B.E. (Part–Time) Fourth Semester Electrical and Electronics Engineering –Regulation 2009/2010)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the essential elements for generating emf in alternators?

2. Two reaction theory is applied only to salient pole machines. State the reason.

3. What is meant by 'synchronous condenser'?

4. What could be the reasons if a 3-phase synchronous motor fails to start?

5. Define 'slip' of an induction motor.

6. What are the merits and demerits of double squirrel cage induction motors?

7. What type of protection is provided in the starter meant for 3-phase induction motors?

8. While controlling the speed of an induction motor, how is super-synchronous speed achieved?

9. How is the direction of rotation of a single phase induction motor reversed?

10. What is the principle of reluctance motor?

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) Develop the formula for the induced emf in an alternator. (6)

(ii) Describe the method of determining the voltage regulation of an alternator by synchronous impedance method. (10)

Or

(b) (i) Describe the salient constructional features of ac generators driven by (1) diesel engines. (2). steam engines. (12)

(ii) A 3-phase star-connected salient pole synchronous generator is driven at a speed near synchronous with the field circuit open, and the stator is supplied from a balanced 3-phase supply. Voltmeter connected across the line gave minimum and maximum readings of 2800 volts and 2820 volts. The line current fluctuated between 360 A and 275 A. Find the direct and quadrature-axis reactances per phase. Neglect armature resistance. (4)

12. (a) (i) Explain V curves as applied to synchronous motors. (6)

(ii) Describe the different methods of starting a synchronous motor. (10)

Or

(b) (i) A 3-phase, star-connected synchronous motor rated at 187 kVA, 2300 V, 47 A, 50 Hz, 187.5 rpm has an effective resistance of 1.5 Ω and a synchronous reactance of 20 Ω per phase. Determine the internal power developed by the motor when it is operating at rated current and 0.8 power factor leading. (6)

(ii) What are 'constant excitation circles and constant power circle' for a synchronous motor? How are they derived? (10)

13. (a) (i) Explain the working principle of a 3-phase induction motor. (8)

(ii) Draw and explain the slip-torque characteristics of a typical 3-phase induction motor. Mark the starting torque and maximum torque regions on the diagram so drawn. (8)

Or

(b) (i) An induction motor has an efficiency of 0.9 when the shaft load is 45 kW. At this load, stator ohmic loss and rotor ohmic loss each is equal to the iron loss. The mechanical loss is one-third of the no-load losses. Neglect ohmic losses at no-load. Calculate the slip. (8)

(ii) Describe the principle of operation of synchronous induction motor. (8)

14. (a) (i) A 3-phase 440 V distribution circuit is designed to supply not more than 1200 A. Assuming that a 3-phase squirrel cage induction motor has full-load efficiency of 0.85 and a full- load power factor of 0.8 and that the starting current at rated voltage is 5 times the rated full-load current, what is the maximum permissible kW rating of the motor if it is to be started using an auto-transformer stepping down the voltage to 80%? (4)

(ii) With neat diagrams. explain the slip-power recovery schemes as applied to wound-rotor induction motors. (12)

Or

(b) (i) With the help of a neat diagram, explain the working of a star-delta starter for a three-phase induction motor. (10)

(ii) Describe the method of speed control of a 3-phase squirrel cage induction motor by changing the number of stator poles and state the applications of this method. (6)

15. (a) (i) Derive the equivalent circuit of a single phase induction motor with the help of double field revolving theory. (8)

(ii) Explain the no-load test and blocked rotor test for obtaining the equivalent circuit parameters of a single phase induction motor. (8)

Or

(b) (i) Explain the constructional details, principle of operation and the applications of Hysteresis motor. (10)

(ii) What modifications have to be done on a DC series motor to make it to work with single phase AC supply? State the applications of AC series motors. (6)

Reg. No. :

Question Paper Code : 71507

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Fifth Semester

Electrical and Electronics Engineering

EE 2302/EE 52/EE 1301/10133 EE 505 — ELECTRICAL MACHINES – II

(Common to PTEE 2302/10133 EE 505 — Electrical Machines II for B.E. (Part-Time) Fourth Semester Electrical and Electronics Engineering – Regulation 2009/2010)

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish the use of salient pole and round rotor synchronous machines.

2. Draw typical open circuit and short circuit characteristics of synchronous machine.

3. Draw the typical torque angle characteristics of synchronous machine.

4. Why can't the synchronous motors self start? Explain.

5. How much is the developed torque in an induction motor at synchronous speed? Explain.

6. State a method by which starting torque of the induction motor can be increased.

7. State an important distinguishing factor of induction generator and alternator.

8. Draw the torque speed characteristics of an induction motor whose rotor resistance is very large compared to rotor inductance.

9. Distinguish the terms rotating and pulsating magnetic fields.

10. State the limitations of shaded pole motors.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain the EMF and MMF method of evaluating the synchronous reactance.

(ii) A 220V, 50Hz, 6-pole star connected alternator with ohmic resistance of 0.06 ohm per phase, gave the following data for open-circuit, short-circuit and full load zero-power-factor characteristics. Find the percentage voltage regulation at full-load current of 40A at power-factor of 0.8 lag by (1) emf method (2) mmf method and (3) zpf method. Compare the results so obtained.

Field current, A	0.20	0.40	0.60	0.80	1.00	1.20
Open-circuit voltage, Emf in V	29.0	58.0	87.0	116	146	172
Short-circuit current, L_{sc} in A	6.6	13.2	20.0	26.5	32.4	40.0
Z p.f. terminal voltage in V	–	–	–	–	–	0
Field current, A	1.40	1.80	2.20	2.60	3.00	3.40
Open-circuit voltage, Emf in V	194	232	261.5	284	300	310
Short-circuit current, L_{sc} in A	46.3	59.0	–	–	–	–
Z p.f. terminal voltage in V	29	88	140	177	208	230

Or

(b) (i) Derive an expression for real and reactive power outputs of asynchronous generator. (10)

(ii) Illustrate a method for determining the direct and quadrate axis reactances of a salient pole synchronous generator. (6)

12. (a) Illustrate through neat phasor diagram, the functioning of synchronous machine with varying excitation under constant real power load.

Or

(b) Illustrate the phenomenon of hunting and the use of damper winding with the help of dynamic equations.

13. (a) (i) Draw the equivalent circuit and derive expressions for maximum torque and power of a three phase induction motor. (8)

(ii) A 6-pole, 50 Hz, 3-phase induction motor running on full load develops a useful torque of 160 Nm when the rotor emf makes 120 complete cycles per minute. Let, the mechanical torque lost in friction and core-loss is 10 Nm. Determine the following,

(1) shaft power output,

(2) input to the motor, and

(3) efficiency

Let the total stator loss be 800W. (8)

Or

(b) (i) Draw the torque slip characteristics of an induction motor for varying frequency, stator voltage and rotor resistance. (8)

(ii) A 400 V, 6-pole, 3-phase, 50 Hz star-connected induction motor running light at rated voltage takes 7.5A with a power input of 700 W. With the rotor locked and 150 V applied to the stator, the input current is 35 A and power input is 4000 W; the stator resistance/phase being 0.55 ohms under these conditions. The standstill reactances of the stator and rotor as seen on the stator side are estimated to be in the ratio of 1:0.5. Determine the parameters of the equivalent circuit. (8)

14. (a) (i) Illustrate any two methods used for starting an induction motor. (8)

(ii) A small squirrel-cage induction motor has a starting current of six times the full-load current and a full-load slip of 0.05. Find in p.u of full-load values, the current (line) and starting torque with the following methods of starting

(1) direct switching,

(2) autotransformer starting with motor current limited to 2 p.u and

(3) star-delta starting. (8)

Or

(b) (i) Illustrate the phenomena of Cogging and Crawling in induction motor. (8)

(ii) The impedances at standstill of the inner and outer cages of a double-cage rotor are $(0.01 + j\,0.5)\,\Omega$ and $(0.05 + j\,0.1)\,\Omega$ respectively. The stator impedance may be assumed to be negligible. Determine the ratio of the torques due to the two cages (1) at starting, and (2) when running with a slip of 5%. (8)

15. (a) (i) Illustrate the operation of single phase induction motor with double field revolving theory. (8)

(ii) A 220V, 6-pole, 50Hz, single-winding single-phase induction motor has the following equivalent circuit parameters as referred to the stator.

$R_{1m} = 3.0\,\Omega$, $X_{1m} = 5.0\,\Omega$

$R_2 = 1.5\,\Omega$, $X_2 = 2.0\,\Omega$

Neglect the magnetizing current. When the motor runs at 97% of the synchronous speed, compute the following:

(1) The ratio E_{mf}/E_{mb}.

(2) The ratio T_f/T_b.

(3) The gross total torque. (8)

Or

(b) (i) Explain the theory of Brushless DC Machine. (8)

(ii) Write short notes on Stepper Motor. (8)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 27221

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fifth Semester

Electrical and Electronics Engineering

EE 6504 — ELECTRICAL MACHIINES – II

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by armature reaction in alternator?

2. Define Voltage regulation of an alternator.

3. When is synchronous motor is said to receive 100% excitation?

4. What are the causes of hunting?

5. State the condition for maximum torque of an induction motor under running condition.

6. Why the rotor slots are slightly skewed in squirrel cage induction motor?

7. What is the effect of change in supply voltage on starting torque of induction motor?

8. List out the methods of speed control of cage type 3 phase induction motor.

9. Why single phase induction motor is not self starting? Mention any one method of starting.

10. How can the direction of a capacitor run motor be reversed?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Define armature reaction and explain the effect of armature reaction on different power factor loads of synchronous generators. (8)

(ii) Derive the emf equation of an alternator. (8)

Or

(b) A 3 phase, Y-connected, 1000 KVA, 2000 V, 50 Hz alternator gave the following open-circuit and short circuit test readings:

Field current (A)	10	20	25	30	40	50
O.C. Voltage (V)	800	1500	1760	2000	2350	2600
S.C. armature current (A)	–	200	250	300	–	–

The armature effective resistance per phase is $0.2\,\Omega$ Draw the characteristic curves and determine the full load percentage regulation at (i) 0.8 p.f lagging, (ii) 0.8 p.f leading by MMF method. (16)

12. (a) (i) Draw and explain the phasor diagram of a synchronous motor operating at lagging and leading power factor. (8)

(ii) Explain V and inverted V curves applied to synchronous motor. (8)

Or

(b) (i) A 1000 KVA, 11000 V, 3—phase star-connected synchronous motor has an armature resistance and reactance per phase of $3.5\,\Omega$ and $40\,\Omega$ respectively. Determine the induced emf and angular retardation of the rotor when fully loaded at 0.8 p.f. lagging and 0.8 p.f. leading. (8)

(ii) Derive the expression for power delivered by a synchronous motor in terms of load angle (α). (8)

13. (a) Sketch and explain the torque slip characteristics of the 3 phase cage and slip-ring induction motors. Show the stable region in the graph. (16)

Or

(b) (i) A 3 phase induction motor has a starting torque of 100% and a maximum torque of 200% of the full load torque. Determine:

(1) Slip at which maximum torque occurs;

(2) Full load slip;

(3) Rotor current at starting in per unit of full-load rotor current. (8)

(ii) Explain the working principle of 3 phase induction motor. (8)

14. (a) (i) Explain the method of starting of slip ring induction motor. (8)

(ii) Explain the speed control of a 3 phase induction motor using voltage control and frequency control. (8)

Or

(b) Explain the speed control of 3 phase induction motor with slip power recovery scheme. (16)

15. (a) (i) Explain the operating principle of hysteresis motor with neat diagram. (8)

(ii) Explain the operating principle of Linear Induction motor with neat diagram. (8)

Or

(b) Using double field revolving theory, explain why a single phase induction motor is not self starting. Also obtain the equivalent circuit of single phase induction motor with necessary equations. (16)

Reg. No. 3 1 2 4 1 3 1 0 5 3 1 2

Question Paper Code : 57324

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Fifth Semester

Electrical and Electronics Engineering

EE6504 – ELECTRICAL MACHINES – II

(Regulations 2013)

Time : Three Hours **Maximum : 100 Marks**

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. How can you distinguish between the two types of large synchronous generator from their appearance ?

2. Define voltage regulation.

3. List the inherent disadvantages of synchronous motor.

4. How can we change the operating speed of synchronous motor ?

5. Why are the slots on the cage rotor of induction motor usually skewed ?

6. Write down the condition to get maximum torque under running condition.

7. What is the effect of change in input voltage on starting torque of induction motor ?

8. How can the direction of a capacitor run motor be reversed ?

9. Name the motor being used in ceiling fans.

10. Why single phase induction motor is not self starting ? Mention any one method of starting.

PART – B (5 × 16 = 80 Marks)

11. (a) (i) Explain the concept of armature reaction and mention the methods to reduce this effect. **(8)**

(ii) In a 50-KVA, Y-connected, 440-V, 3-phase, 50 Hz alternator, the effective armature resistance is 0.25 Ω / phase. The synchronous reactance is 3.2 Ω/ phase and leakage reactance is 0.5 Ω / phase. Determine at rated load at unity power factor : (a) Internal e.m.f E_a, (b) no-load e.m.f, E_0, (c) percentage regulation on full load, (d) value of synchronous reactance which replaces armature reaction. **(8)**

OR

(b) The following data were obtained for the OCC of a 10 MVA, 13 KV, 3-phase, 50 Hz, Y-connected synchronous generator.

Field current (A) :	50	75	100	125	150	162.5	200	250	300
O.C. Voltage (KV) :	6.2	8.7	10.5	11.8	12.8	13.2	14.2	15.2	15.9

An excitation of 100 A causes the full-load current to flow during the short-circuit test. The excitation required to give the rated current at zero pf and rated voltage is 290 A.

(i) Calculate the adjusted synchronous reactance of the machine.

(ii) Calculate the leakage reactance of the machine assuming the resistance to be negligible.

(iii) Determine the excitation required when the machine supplies full-load at 0.8 pf lagging by using the leakage reactance and drawing the mmf phasor diagram. What is the voltage regulation of the machine ? Also calculate the voltage regulation for this loading using the adjusted synchronous reactance. Compare and comment upon the two results. **(16)**

12. (a) (i) Explain in detail V and inverted V curves of a synchronous motor. **(8)**

(ii) Explain in detail the method of starting of synchronous motor. **(8)**

OR

(b) (i) A 3300 V, delta connected motor has a synchronous reactance per phase of 18 Ω. It operates at a leading power factor of 0.707 when drawing 800 KW from the mains. Calculate its excitation emf. **(8)**

(ii) Enumerate in detail the effect of varying excitation on armature current and power factor of synchronous motor. **(8)**

13. (a) (i) Derive the expression for torque, slip and draw speed-torque characteristics of 3-phase induction motor. **(8)**

(ii) Explain in detail the construction of circle diagram of an induction motor. **(8)**

OR

(b) (i) Explain in detail the equivalent circuit of 3-phase induction motor. **(8)**

(ii) A 40 kW, 3-phase, slip-ring induction motor of negligible stator impedance runs at a speed of 0.96 times synchronous speed at rated torque. The slip at maximum torque is four times the full-load value. If the rotor resistance of the motor is increased by 5 times, determine :

(a) The speed, power output and rotor copper loss at rated torque.

(b) The speed corresponding to maximum torque. **(8)**

14. (a) (i) Explain in detail the speed control methods of induction motor. **(8)**

(ii) Explain in detail the scherbius system of speed control. **(8)**

OR

(b) (i) Describe a starter available for a 3-phase slip ring induction motor. **(8)**

(ii) A small squirrel-cage induction motor has a starting current of six times the full load current and a full-load slip of 0.05. Find in pu of full-load values, the current (line) and starting torque with the following methods of starting ((a) to (d)). (a) Direct switching, (b) Stator-resistance starting with motor current limited to 2p.u, (c) auto-transformer starting with motor current limited to 2p.u, and (d) Y-delta starting. (e) What auto transformer ratio would give 1pu starting torque ? **(8)**

15. (a) (i) Explain in detail the operation of capacitor start and run induction motor. **(8)**

(ii) Discuss in detail the operation of hysteresis motor. **(8)**

OR

(b) Write short notes on the following :

(i) Linear Induction motor and **(8)**

(ii) AC series motor **(8)**

Reg. No. : 3 1 0 8 1 3 1 0 5 0 6 1

Question Paper Code : 80380

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Fifth Semester

Electrical and Electronics Engineering

EE 6504 — ELECTRICAL MACHINES — II

(Regulations 2013)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish between full-pitch coil and short-pitch coil.
2. What are the conditions of parallel operation of alternators?
3. What are the various functions of damper winding provided with synchronous motor?
4. What is meant by hunting?
5. How can the direction of rotation of 3 phase induction motor be reversed?
6. What is the advantages of skewing the rotor slots?
7. Why is a starter needed for starting a large capacity induction motor?
8. What are the starting methods of three phase induction motor?
9. State the application of shaded pole motor.
10. Define the term step angle in a stepper motor.

PART B — (5 × 16 = 80 marks)

11. (a) List the methods used to predetermine the voltage regulation of synchronous machine and explain the MMF method. (16)

Or

(b) (i) Describe with neat sketches, the constructional details of a salient pole type alternator. (10)

(ii) Derive the emf equation of an Alternator. (6)

12. (a) Explain about the starting methods of synchronous motor. (16)

Or

(b) Draw the V-and inverted V-curves and explain the effect of excitation on armature current and power factor of synchronous motor. (16)

13. (a) (i) Develop the approximate equivalent circuit of a 3 phase induction motor. (8)

(ii) Draw and explain the torque-Slip characteristics of a 3 phase induction motor. (8)

Or

(b) (i) Explain the operation of Induction machine as a generator with neat diagram. (8)

(ii) Explain the speed torque characteristics of double cage induction motor with a neat diagram. (8)

14. (a) Explain the speed control methods of a three phase induction motor. (16)

Or

(b) With neat diagrams, explain the working of (i) Star-Delta Starter (ii) Auto Transformer Starter for 3 phase induction motor. (16)

15. (a) (i) Explain the operation of a single phase induction motor using double field revolving theory. (8)

(ii) Discuss with neat diagram the operation of shaded pole IM. (8)

Or

(b) Explain the construction and working principle of

(i) A.C. Series motor. (8)

(ii) Hysteresis motor. (8)

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Reg. No. | | | | | | | | | | | | |

Question Paper Code : 60507

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Fifth Semester

Electrical and Electronics Engineering

EE 2302/EE 52/EE 1301/10133 EE 505 — ELECTRICAL MACHINES — II

(Regulations 2008/2010)

(Common to PTEE 2302/10133 EE 505 — Electrical Machines II for B.E. (Part – Time) Fourth Semester – Electrical and Electronics Engineering – Regulations 2009/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Distinguish the use of salient pole and round rotor synchronous machines.

2. Draw typical open circuit and short circuit characteristics of synchronous machine.

3. What is meant by hunting of a synchronous motor?

4. What are the uses of damper winding in synchronous motor?

5. How the direction of rotation of a three—phase induction motor can be — reversed?

6. What is an induction generator?

7. What is the effect of increasing the rotor resistance on starting current and torque?

8. List out the methods of speed control of cage type 3Φ induction motor.

9. Draw the torque slip characteristics of single phase induction motor.

10. What will be the direction of rotation of a shaded pole single phase induction motor?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain the EMF and MMF method of evaluating the synchronous reactance.

(ii) A 220 V, 50 Hz, 6-pole star connected alternator with ohmic resistance of 0.06 ohm per phase, gave the following data for open-circuit, short-circuit and full load zero-power-factor characteristics. Find the percentage voltage regulation at full-load current of 40A at power-factor of 0-8 lag by (1) emf method (2) mmf method and (3) zpf method. Compare the results so obtained.

Field current, A	0.20	0.40	0.60	0.80	1.00	1.20
Open-circuit voltage, Emf in V	29.0	58.0	87.0	116	146	172
Short-circuit current, Lsc in A	6.6	13.2	20.0	26.5	32.4	40.0
Z.p.f. terminal voltage in V	–	–	–	–	–	0
Field current, A	1.40	1.80	2.20	2.60	3.00	3.40
Open-circuit voltage, Emf in V	194	232	261.5	284	300	310
Short-circuit current, Lsc in A	46.3	59.0	–	–	–	–
Z p.f terminal voltage in V	29	88	140	177	208	230

Or

(b) (i) Derive an expression for real and reactive power outputs of asynchronous generator. (10)

(ii) Illustrate a method for determining the direct and quadrate axis reactances of a salient pole synchronous generator. (6)

12. (a) The synchronous reactance per phase of a 3-phase, star connected 6600 V synchronous motor is 20 Ω. For a certain load the input is 900 kW at normal voltage and the induced line emf is 8500 V. Determine the line current and power factor. (16)

Or

(b) (i) Explain V curves and inverted V curves of a synchronous motor. (8)

(ii) Draw and explain the equivalent circuit and phasor diagram of a cylindrical rotor synchronous motor operating at different power factors. (8)

13. (a) (i) Deduce and discuss the equivalent circuit of 3Φ induction motor. (8)

(ii) Explain with neat diagram, the constructional features and working principle of a 3Φ induction motor. (8)

Or

(b) Sketch and explain the torque slip characteristics of the $3\ \Phi$ cage and slip-ring induction motors. Show the stable region in the graph. (16)

14. (a) (i) State the different methods of starting of 3—phase induction motor and discuss in detail any two methods. (8)

(ii) With aid of diagrams explain the principle of the following methods of speed control of a 3—phase induction motor.

(1) variable Frequency

(2) cascade connection. (8)

Or

(b) (i) Describe a starter suitable for a 3—phase slip—ring induction motor. (6)

(ii) Determine approximately the starting torque of an induction motor in terms of full load torque when started by

(1) Star—delta starter and

(2) Auto—starter with 50% tapping. The short circuit current of the motor at normal voltage is 5 times the full load current and the full load slip is 4%. (10)

15. (a) (i) Using double revolving field theory explain why a single phase induction motor is not self starting. (8)

(ii) The equivalent impedances of the main and auxiliary windings in a capacitor motor are $(15 + j\,22.5)\ \Omega$ and $(50 + j\,120)\ \Omega$ respectively, while the capacitance of the capacitor is 12 μF. Determine the line current at starting on a 230 V, 50Hz supply. (8)

Or

(b) Explain the operation and constructional features of

(i) Capacitor start single phase induction motor

(ii) AC series motor. (16)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 71779

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Fifth Semester

Electrical and Electronics Engineering

EE 6504 — ELECTRICAL MACHINES — II

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What do you mean by single layer and double layer winding?

2. Define voltage regulation.

3. What are V – curves?

4. What is synchronous condenser?

5. Why are the slots on the cage rotor of induction motor usually skewed?

6. A 3-phase, 4-pole induction motor operates from a supply whose frequency is 50Hz. Calculate the frequency of the rotor current at standstill and the speed at which the magnetic field of the stator is rotating.

7. What is the effect of change in input voltage on starting torque of induction motor?

8. State two advantages of speed control of induction motor by injecting an e.m.f in the rotor circuit.

9. Define double field revolving theory.

10. Why single phase induction motor is not self starting? Mention any one method of starting.

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) Explain step by step method of potier triangle method of determining the regulation of an alternator. (8)

(ii) A 30MVA, 15KV, 60Hz ac generator has a synchronous reactance of 1.2pu and a resistance of 0.02 pu. Calculate

(1) the base voltage, base power and base impedance of the generator,

(2) the actual value of the synchronous reactance,

(3) the actual winding resistance, per phase

(4) the total full-load copper losses. (8)

Or

(b) A 3 phase Y-connected, 1000 KVA, 2000 V, 50 Hz alternator gave the following open-circuit and short circuit test readings :

Field current (A) :	10	20	25	30	40	50
O.C. Voltage (V) :	800	1500	1760	2000	2350	2600
S.C. armature current (A) :	–	200	250	300	–	–

The armature effective resistance per phase is 0.2Ω. Draw the characteristic curves and determine the full load percentage regulation at

(i) 0.8 p.f lagging,

(ii) 0.8 p.f leading by MMF method. (16)

12. (a) (i) Explain V – curve and inverted V curve. (8)

(ii) A 500 hp, 720 rpm synchronous motor connected to a 3980V, 3phase line generates an excitation voltage E_o of 1790V (line to neutral) when the dc exciting current is 25A. The synchronous reactance is 22Ω and the torque angle between E_o and E is 30°, calculate

(1) The value of E_x

(2) The ac line current

(3) The power factor of the motor

(4) The approximate horsepower developed by the motor

(5) The approximate torque developed at the shaft. (8)

Or

(b) (i) A 1000 KVA, 11000 V, 3–phase star-connected synchronous motor has an armature resistance and reactance per phase of 3.5Ω and 40Ω respectively. Determine the induced emf and angular retardation of the rotor when fully loaded at 0.8 p.f. lagging and 0.8 p.f. leading. (8)

(ii) Derive the expression for power delivered by a synchronous motor in terms of load angle (α). (8)

13. (a) Explain in detail the construction of circle diagram of an induction motor. (16)

Or

(b) (i) Sketch and explain the torque slip characteristics of the 3 phase cage and slip-ring induction motors. Show the stable region in the graph. (8)

(ii) A 3 phase, 25 KW, 400 V, 50 Hz, 8-pole induction motor has rotor resistance of 0.08 ohm and standstill resistance of 0.4 ohm. The effective stator/ rotor turn ratio is 2.5/1. The motor is to drive a constant-torque load of 250N-m. Neglect stator impedance

(1) Calculate the minimum resistance to be added in rotor circuit for the motor to start up on load.

(2) At what speed would the motor run, if the added rotor resistance is (A) left in the circuit, and (B) subsequently short circuited. (8)

14. (a) The results of the no-load and blocked rotor tests on a 3-phase, Y-connected 10KW, 400V, 17A, 50Hz, 8-pole induction motor with a squirrel-cage rotor are given below.

No- load test :	Line-line voltage	=	400V
	Total input power	=	467W
	Line current	=	6.8A
Blocked rotor tests :	Line-line voltage	=	180V
	Total input power	=	1200W
	Line current	=	17A

The dc resistance of the stator measured immediately after the blocked rotor test is found to have an average value of 0.68 ohm/phase. Calculate the parameters of the circuit model of the induction motor. Draw circuit model. Calculate

(i) Torque (net),

(ii) Stator current,

(iii) Power factor,

(iv) Efficiency. (16)

Or

(b) Explain the speed control of 3 phase induction motor with slip power recovery scheme. (16)

15. (a) Using double field revolving theory, explain why a single phase induction motor is not self starting. Also obtain the equivalent circuit of single phase induction motor with necessary equations. (16)

Or

(b) Describe the constructional features and principle of operation of hysteresis motor and AC series motor. (16)

Reg. No. :

Question Paper Code : 50488

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017
Fifth Semester
Electrical and Electronics Engineering
EE 6504 – ELECTRICAL MACHINES – II
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. What is the necessity of chording in the armature winding of a synchronous machine ?
2. Distinguish between transient and sub-transient reactances.
3. A 3-phase synchronous motor driving a constant load torque draws power from infinite bus at leading power factor. How power angle and power factor will change if the excitation is increased ?
4. What is the role of damper winding in synchronous motor ?
5. What measure can be taken for minimizing the effect of crawling in a 3-phase induction motor ?
6. Draw the torque-slip characteristic of double-cage induction motor.
7. Why is rotor rheostat starter unsuited for a squirrel cage motor ?
8. What are the conditions for regenerative braking of an induction motor to be possible ?
9. How is the direction of rotation of a single phase induction motor reversed ?
10. What is the principle of operation of a linear induction motor ?

PART – B (5×13=65 Marks)

11. a) i) Derive the EMF equation of a 3-phase synchronous machine. (6)

ii) Describe how the direct and quadrature-axis reactances of a salient-pole synchronous machine can be estimated by means of slip test. (7)

(OR)

b) i) What is meant by Synchronizing ? State the conditions for paralleling alternator with infinite busbars. (5)

ii) Explain the Ampere-Turn method of finding voltage regulation of an alternator. (8)

12. a) i) Describe the principle of operation of synchronous motor. (5)

ii) What are the methods of starting a synchronous motor ? Explain any one of them with a circuit diagram. (8)

(OR)

b) i) What are 'constant excitation circles and constant power circle' for a synchronous motor ? How are they derived ? (8)

ii) Explain briefly how a synchronous motor can be operated as a synchronous condenser. (5)

13. a) i) Describe the working principle of a 3-phase induction motor. (7)

ii) An induction motor has an efficiency of 0.9 when the shaft load is 45 kW. At this load, stator ohmic loss and rotor ohmic loss each is equal to the iron loss. The mechanical loss is one-third of the no-load losses. Neglect ohmic losses at no-load. Calculate the slip. (6)

(OR)

b) i) Derive the expression for torque under running condition of a 3-phase induction motor and obtain the condition for maximum torque. (8)

ii) Write short notes on 'Induction generators'. (5)

14. a) i) With a neat diagram, explain the working of a star-delta starter for a 3-phase induction motor. **(8)**

ii) Describe the method of speed control of a 3-phase squirrel cage induction motor by changing the number of stator poles and state the applications of this method. **(5)**

(OR)

b) i) Draw and explain the schematic diagram of a static Kramer variable-speed drive system for a slip ring induction motor. **(7)**

ii) Explain the dc dynamic braking of a 3-phase induction motor. **(6)**

15. a) i) Explain the two field revolving theory for single phase induction motors. **(8)**

ii) Describe the principle of operation of Hysteresis motor. **(5)**

(OR)

b) i) Explain the no-load and blocked rotor tests on a single phase induction motor. **(7)**

ii) Describe the working principle of any one type of stepper motor. **(6)**

PART – C **(1×15=15 Marks)**

16. a) Explain the V/F control technique in 3ϕ IM. **(15)**

(OR)

b) With neat diagram, explain the construction and operation of shaded pole induction motor. **(15)**

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Reg. No. : 3 1 0 8 1 3 1 0 5 1 0 4

Question Paper Code : 41006

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018

Fifth Semester

Electrical and Electronics Engineering

EE6504 – ELECTRICAL MACHINES – II

(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Two reaction theory is applied only to salient pole machines. State the reason.
2. What are the advantages of salient pole type construction used for Synchronous machines ?
3. How the synchronous motor can be used as synchronous condenser ?
4. How does a change of excitation affect its power factor ?
5. Why an induction motor will never run at its synchronous speed ?
6. Explain why an induction motor, at no-load, operates at very low power factor.
7. What is the need of starter for induction motor ?
8. What are the advantages of slip power scheme ?
9. What are the various methods available for making a single-phase motor self-starting ?
10. What is the principle of reluctance motor ?

PART – B (5×13=65 Marks)

11. a) Explain the procedure for POTIER method to calculate voltage regulation of alternator. (13)

(OR)

b) Describe the principle and construction of slow speed operation generator with neat diagram. (13)

12. a) A 5 kW, three-phase Y-connected 50 Hz, 440 V, cylindrical rotor synchronous motor operates at rated condition with 0.8 pf leading . The motor efficiency excluding field and stator losses is 95% and Xs = 2.5 Ω. Calculate :

i) Mechanical power developed

ii) Armature current

iii) Back emf

iv) Power angle

v) Maximum or pull out torque of the motor. (13)

(OR)

b) Explain the working of synchronous motor with different excitations. (13)

13. a) Explain the construction and working of three phase induction motor. (13)

(OR)

b) Develop an equivalent circuit for three phase induction motor. State the difference between exact and approximate equivalent circuit. (13)

14. a) Explain with neat diagram, the working of any two types of starters used for squirrel cage type three phase induction motor. (13)

(OR)

b) Explain briefly the various speed control schemes of induction motor. (13)

15. a) Give the classification of single phase motors. Explain any two types of single phase induction motor. (13)

(OR)

b) What is the principle and working of hysteresis motor and AC series motor ? Explain briefly. (13)

PART – C

(1×15=15 Marks)

16. a) A 415 V, 11kW , 50 Hz, delta connected, three-phase energy efficient induction motor gave the following test results :

No load test : 415 V; 5.8 A; 488 W

Blocked rotor test : 40 V; 18.4 A; 510 W

Stator resistance per phase = 0.7 Ω.

For full-load condition, find

i) line current

ii) power factor

iii) input power

iv) slip and

v) efficiency.

(OR)

b) A 1.1 MVA, 2.2 kV, 3-phase, star -connected alternator gave the following test result during OC and SC tests :

Field current (A)	:	10	20	30	40	50
Open circuit voltage(kV)	:	0.88	1.65	2.20	2.585	2.86
Short circuit current (A)	:	200	400	–	–	–

The effective resistance of the 3-phase winding is 0.22 Ω/ph. Estimate the full-load voltage regulation at 0.8 p.f. lagging

i) By synchronous impedance method and

ii) Ampere-turn method.