ELECTRICAL MACHINES-II

Subject Code : EE403PC
Regulations : R18 - JNTUH
Class : II Year B.Tech EEE II Semester

Department of Electrical and Electronics and Engineering

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

Ibrahimpatnam - 501 510, Hyderabad

ELECTRICAL MACHINES-II (EE403PC)
COURSE PLANNER

I. OBJECTIVE AND RELEVANCE:

The main objective of this subject is to understand and to know the following concepts:

- To deal with the detailed analysis of poly phase induction motors & Synchronous Generators and motors
- To understand operation, construction and types of single phase motors and their applications in house hold appliances and control systems.
- To introduce the concept of parallel operation of synchronous generators.
- To introduce the concept of regulation and its calculations.

II. PREREQUISITES:

The knowledge of following subjects is essential to understand this subject:

- Electrical Machines-I
- Basic concepts about electrical energy conversion principles.
- Knowledge in Mathematics.

III. COURSE OUTCOME:

S.No	Description	Bloom's Taxonomy Level
CO1	***Understand*** the construction and working of 3-φ Induction machines.	Knowledge, Understand (Level 1, Level 2)
CO2	***Understand*** the characteristics and different speed control methods of 3-φ Induction motor.	Knowledge, Applying (Level1, Level 3)
CO3	***Understand*** the construction and working of Alternator.	Knowledge, Understand (Level 1, Level 2)
CO4	***Analyze*** different methods to find the regulation of alternators.	Analyzing, Evaluating (Level 4, Level 5)
CO5	***Understand*** the parallel operation of alternators and operation of synchronous motor.	Understand, Analyzing (Level 2, Level 4)
CO6	***Understand*** the operation of different 1-φ Induction motors.	Knowledge, Understand (Level 1, Level 2)

IV. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (PO)		Level	Proficiency assessed by
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**3**	**Lectures, Assignments university exams.**
PO2	**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.	**2**	**Slip tests, Surprise tests and Mock tests**
PO3	**Design/Development Analysis:**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.	**2**	**Hands on Practice sessions**
PO4	**Conduct Investigations of Complex Problems:**Use research-based	**2**	**Lab Sessions and**

	knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.		**model developments**
PO5	**Modern Toll 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.	**2**	**Practices new Soft computing techniques**
PO6	**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.	**2**	**Seminars & Project work**
PO7	**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.	**-**	**--**
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**-**	**--**
PO9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	**-**	**--**
PO10	**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.	**2**	**Seminars, Discussions**
PO11	**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.	**2**	**Develop new projects**
PO12	**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.	**2**	**Research**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: None

V. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSO)		Level	Proficiency assessed by
PSO1	Talented to analyze, design, and implement electrical & electronics systems and deal with the rapid pace of industrial innovations and developments.	**2**	**Lectures, Assignments.**
PSO2	Skillful to use application and control techniques for research and advanced studies in Electrical & Electronics Engineering domain.	**2**	**Participate events, seminars & symposiums**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: None

VI.SYLLABUS:

JNTUH SYLLABUS

UNIT – I

Polyphase Induction Motors: Constructional details of cage and wound rotor machinesproduction of a rotating magnetic field - principle of operation - rotor EMF and rotor frequency - rotor reactance, rotor current and Power factor at standstill and during operation.

UNIT - II

Characteristics of Induction Motors: Rotor power input, rotor copper loss and mechanical power developed and their inter relation-torque equation-deduction from torque equation - expressions for maximum torque and starting torque - torque slip characteristic – equivalent circuit - phasor diagram -crawling and cogging -.No-load Test and Blocked rotor test – Predetermination of performance Methods of starting and starting current and Torque calculations.

Speed Control Methods: Change of voltage, change of frequency, voltage/frequency, injection of an EMF into rotor circuit (qualitative treatment only)-induction generatorprinciple of operation.

UNIT – III

Construction, Principle of operation, Characteristics & Regulation of Synchronous Generator: Constructional Features of round rotor and salient pole machines – Armature windings – Integral slot and fractional slot windings; Distributed and concentrated windings – distribution, pitch and winding factors – E.M.F Equation. Harmonics in generated e.m.f. – suppression of harmonics –armature reaction – leakage reactance – synchronous reactance and impedance – experimental determination – phasor diagram – load characteristics.

Regulation by synchronous impedance method, M.M.F. method, Z.P.F. method and A.S.A. methods – salient pole alternators – two reaction analysis – experimental determination of Xd and Xq (Slip test) Phasor diagrams – Regulation of salient pole alternators.

UNIT - IV

Parallel Operation of Synchronous Generator: Synchronizing alternators with infinite bus bars –synchronizing power torque – parallel operation and load sharing - Effect of change of excitation and mechanical power input. Analysis of short circuit current wave form – determination of sub-transient, ransient and steady state reactances.

Synchronous Motors – Principle of Operation: Theory of operation – phasor diagram – Variation of current and power factor with excitation – synchronous condenser – Mathematical analysis for power developed .- hunting and its suppression – Methods of starting – synchronous induction motor.

UNIT - V

Single Phase Motors & Special Motors:: Single phase induction motor – Constructional features-Double revolving field theory – split-phase motors – shaded pole motor.

- **GATE SYLLABUS:**

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuittests, regulation and efficiency; three phase transformers: connections, parallel operation; Autotransformer, Electromechanical energy conversion principles.

DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors;

Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Operating principle of single phase induction motors;

Synchronous machines: cylindrical and salient pole machines, performance, regulation and parallel operation of generators, starting of synchronous motor, characteristics; Types of losses and efficiency calculations of electric machines.

- **ESE SYLLABUS:**

Single phase transformers, three phase transformers - connections, parallel operation, auto-transformer, energy conversion principles, DC machines - types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors, **Induction motors** - principles, types, performance characteristics, starting and speed control, **Synchronous machines** - performance, regulation, parallel operation of generators, motor starting, characteristics and applications, servo and stepper motors.

SUGGESTED BOOKS:

TEXT BOOKS:

1. “I. J. Nagrath& D. P. Kothari”, “Electric Machines”, Tata Mc Graw Hill, 7^{th} Edition, 2009
2. “**PS** Bhimbra”, “Electrical machines”, Khanna Publishers, 2014.

REFERENCE BOOKS:

1. “M. G. Say”, “Performance and Design of AC Machines”, CBS Publishers, 3rd Edition, 2002.
2. “A.E. Fitzgerald, C. Kingsley and S. Umans”, “Electric machinery”, Mc Graw Hill Companies, 7th edition, 2013
3. “Langsdorf”, “Theory of Alternating Current Machinery”, Tata McGraw-Hill Companies, 2nd edition, 1984.
4. “M.V Deshpande”, “Electrical Machines”, Wheeler Publishing, 2011
5. “J.B.Gupta”, “Electrical Machines Vol. 2”, SkKataria& Sons, 2012.

VII. COURSE PLAN (WEEK-WISE):

LESSON PLAN ACADEMIC YEAR 2020-2021 II SEM

Course Instructor : Bipul Krishna Saha
Class: EEE III (A &B)

Subject: ELECTRICAL MACHINES – II
WEF : 26.3.21

Lecture No.	Unit No.	Topics to be covered	Link for PPT	Link for PDF	Link for Small Projects/ Numericals(if any)	Course learning outcomes	Teaching Methodology	Reference
1	**1**	Introduction	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
2		Machine I Basic	https://drive.google.com/open?id=1MxqsWfktcISJl1xszvskCslYX-J2XpJz	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
3		Types of Motors	https://drive.google.com/open?id=1HLRcl8cBWTk5Qu11xUyV3XyizjCC0J2C	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
4		Poly-Phase Induction Machines	https://drive.google.com/open?id=1UGnIajwprgeSwhVtPP8VODty4uF-UCbf	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
5		Constructional details of cage and wound rotor machines-production of a rotating magnetic field	https://drive.google.com/open?id=1QvvJO-sp0liqnhGpPoOJ5j-B2A7bVuRY	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
6		Principle of operation	https://drive.google.com/open?id=1flliVWCJq7qbvujftAWt	https://drive.google.com/open?id=1Ew2A3ukvX	https://www.electronicshub.org/top-electrical-	UNDERSTAND	PPT / WHITE BOARD	

			F4TaSblCmg2f	kjyHjSNJJuIqF5Txw_9mnNq	mini-projects/			
7		Rotor EMF and rotor frequency	https://drive.google.com/open?id=1hrDXYDzsCG2pztCECx7xUa-VwOPGuxwR	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
8		Rotor reactance	https://drive.google.com/open?id=1E3ZAFh7jBQTqGSg-M07hJWnXwWK4xL4l	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
9		Rotor current	https://drive.google.com/open?id=1x6AYe_GtLsGrqJhChJWbiQkh7doHCGSz	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
10		Power factor at standstill and during operation	https://drive.google.com/open?id=1k4QJEmry1f8r1CksC8gvhtFXK4D3lBQQ	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
11		Revised Principal of operation	https://drive.google.com/open?id=1fiq7FU_EB-r-fQAvcxadoKciohabc-BT	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
12		Electrical machine handtool	https://drive.google.com/open?id=1DellH_IS09SkvslrtIIzQ4fNiej3UXZg	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
13		Simulation Software	https://drive.google.com/open?id=1Ozj4gRkbkJAawbsb7MnVAqkZPO0t9nH3	https://drive.google.com/open?id=1Ew2A3ukvXkjyHjSNJJuIqF5Txw_9mnNq	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
14		Quiz, Revised Unit1, Solved question papers	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://www.electronicshub.org/top-electrical-mini-projects/	NUMERICAL	PPT / WHITE BOARD	
15		Characteristics of Induction Machines	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
16		Rotor power input	https://drive.google.com/open?id=1g83YlXQSPf_G2f6AHM9nvuFfroEJAUPz	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	

17		rotor copper loss and mechanical power developed and their inter relation-torque equation-deduction from torque equation	https://drive.google.com/open?id=1GVtD_UFGRRrs7lZDog5-q8hb1gxkb6gs	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
18		Expressions for maximum torque and starting torque	https://drive.google.com/open?id=1YTqNpafjlvdOiUSuM1jAeiX48XdFPHhk	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
19		Torque slip characteristic - equivalent circuit	https://drive.google.com/open?id=1RCcq7M68fKfmTboLa1xD0XMUnLEpo8Ad	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
20		**phasor diagram - crawling and cogging**	https://drive.google.com/open?id=1u-GthHnnlVAk4koODeMwZJ7eTOeB9g7X	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
21		No-load Test and Blocked rotor test	https://drive.google.com/open?id=1JBgmh8CkK1awVLUmMJW6akElfNBTNGkQ	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
22		Predetermination of performance	https://drive.google.com/open?id=1ibHv7u0LjsUhSYGaG24_LheFjHg8U61_	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
23		Methods of starting and starting current and Torque calculations	https://drive.google.com/open?id=13VvT1dbShqi8Amu1S2jPvZmuj41XageA	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
24		Speed Control Methods: Change of voltage	https://drive.google.com/open?id=1KgCWJgJaE4uqg-iW7Pg-gBabuNQ7JMhT	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
25		Speed Control Methods: Change of voltage	https://drive.google.com/open?id=1lFEM_78Rhn_lHzO4HXZp0UnFLwovU6Hg	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
26		Injection of an EMF into rotor circuit (qualitative treatment only)	https://drive.google.com/open?id=1j3FXVuhySQ7-FAKSC7YjzALhk8VM1AKJ	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	

27		Induction generator-principle of operation	https://drive.google.com/open?id=14p66f7RmHp9HVSr9CZoAdjpNHVkbPpjA	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
28		Quiz, Revised Unit 2, Solved question papers	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://www.electronicshub.org/top-electrical-mini-projects/	NUMERICAL	PPT / WHITE BOARD	
I Mid Examinations								
29		Synchronous Machines: Constructional Features of round rotor and salient pole machines	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
31		Armature windings – Integral slot and fractional slot windi	https://drive.google.com/open?id=1k6s9mQmjUgpuuR0dTlYSx0KslsJP_IQg	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
32		Distributed and concentrated windings	https://drive.google.com/open?id=1mEMKs_rgjgwPQZxfrayzg86QknndR5H_	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
33	**3**	Distribution, pitch and winding factors	https://drive.google.com/open?id=12s6667pndxa1oG6P6Abt3zyL9KEOyvuk	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
34		E.M.F Equation. Harmonics in generated e.m.f. – suppression of harmonics	https://drive.google.com/open?id=1OZJETdp6qjkIYcI1BLHk_hhrvx-sgfrh	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
35		Armature reaction - leakage reactance – synchronous reactance and impedance – experimental determination	https://drive.google.com/open?id=1ZIcTnKD3UK68wZ-COWYTVK03_WNQ8FBj	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
36		phasor diagram – load characteristics. Regulation by synchronous impedance method, M.M.F. method	https://drive.google.com/open?id=1tLg4MyZ5Eonl8oXNykyWG_Al7_iBcajK	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	

37		Z.P.F. method and A.S.A. methods – salient pole altern	https://drive.google.com/open?id=1dlvlsXkz-IiFuFG7V3yisCIZn_AYNec6	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
38		two reaction analysis	https://drive.google.com/open?id=1sGfSUpQd4ZfOkteEfaidJCZ_ef2VGWC	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
39		experimental determination of Xd and Xq (Slip test) Phasor diagrams – Regulation of salient pole alternators.	https://drive.google.com/open?id=1D7EsHSi_eDPCPTZlhnjw8HXKwXNOlEFk	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
40		Quiz, Revised Unit 3, Solved question papers	https://drive.google.com/open?id=1cABBDaJhS5h6NeOfuimz6Q9CYAWyu4Qr	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
41	**4**	Parallel Operation of Synchronous Machines: Synchronizing alternators with infinite bus bars – synchronizing power torque	https://drive.google.com/open?id=1o4CrWpttPC0jXvBIV0blE8lCSiOFpFik	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
42		Parallel operation and load sharing	https://drive.google.com/open?id=1tx-WmCFnqR7kjqwn5e5pccDxVUxYvys_	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
43		Effect of change of excitation and mechanical power input	https://drive.google.com/open?id=1RCcq7M68fKfmTboLa1xD0XMUnLEpo8Ad	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	NUMERICAL	PPT / WHITE BOARD	
44		Analysis of short circuit current wave form – determination of sub-transient	https://drive.google.com/open?id=1lFEM_78Rhn_lHzO4HXZp0UnFLwovU6Hg	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD	
45		**Transient and steady state reactance's.**	https://drive.google.com/open?id=1OZJETdp6qjkIYcI1BLHk_hhrvx-sgfrh	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	
46		Synchronous Motors: Theory of operation – phasor diagram	https://drive.google.com/open?id=1ibHv7u0LjsUhSYGaG24_LheFjHg8U61_	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD	

47		Variation of current and power factor with excitation	https://drive.google.com/open?id=14p66f7RmHp9HVSr9CZoAdjpNHVkbPpjA	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD
48		**Synchronous condenser – Mathematical analysis for power developed**	https://drive.google.com/open?id=1mEMKs_rgjgwPQZxfrayzg86QkndR5H_	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD
49		hunting and its suppression – Methods of starting	https://drive.google.com/open?id=1KgCWJgJaE4uqg-iW7Pg-gBabuNQ7JMhT	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD
50		Synchronous induction motor	https://drive.google.com/open?id=1JBgmh8CkK1awVLUmMJW6akElfNBTNGkQ	https://drive.google.com/open?id=1M2I4EiCJzRhuELafIOOO1j9pzBTNybyj	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD
51		Quiz, Revised Unit 4, Solved question papers	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD
52	**5**	Single Phase & Special Machines: Single phase induction motor	https://drive.google.com/open?id=1K4GxmuX2uI1ZkqORfZni6zo257CPckyT	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD
53		Constructional features-Double revolving field theory	https://drive.google.com/open?id=1K4GxmuX2uI1ZkqORfZni6zo257CPckyT	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD
54		Split-phase motors – shaded pole motor	https://drive.google.com/open?id=1K4GxmuX2uI1ZkqORfZni6zo257CPckyT	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD
55		Machine Factory visit	https://drive.google.com/open?id=1K4GxmuX2uI1ZkqORfZni6zo257CPckyT	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	UNDERSTAND	PPT / WHITE BOARD
56		Silulation work	https://drive.google.com/open?id=1K4GxmuX2uI1ZkqORfZni6zo257CPckyT	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOYY84lQVg8icw	https://www.electronicshub.org/top-electrical-mini-projects/	KNOWLEDGE	PPT / WHITE BOARD
57		Quiz, Revised Unit4, Solved question papers	https://drive.google.com/open?id=1K4GxmuX2uI1ZkqORfZni6zo257CPckyT	https://drive.google.com/open?id=1Hfog0CPO28sSh8_scLDOY	https://www.electronicshub.org/top-electrical-mini-projects/	NUMERICAL	PPT / WHITE BOARD

				Y84lQVg8icw				
58		Quiz, Revised Unit5, Solved question papers	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://drive.google.com/drive/folders/1QHp1R7Q_Jicr1Kkla1vpmMOF2ju3n18o?usp=sharing	https://www.electronicshub.org/top-electrical-mini-projects/	NUMERICAL	PPT / WHITE BOARD	
II Mid Examinations								

*** Topics beyond Syllabus**

TEXT BOOKS:

1. **A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.**
2. **M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.**

VII.MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OFPROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

	Program Outcomes												**Program Specific Outcomes**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	2	3	-	2	-	-	-	2	2	2	1	2
CO2	3	-	-	2	2	-	-	-	-	-	1	3	3	2
CO3	2	1	2	-	2	1	-	-	-	2	2	2	3	1
CO4	3	2	2	1	2	2	-	-	-	2	1	2	2	2
CO5	-	2	-	2	2	1	-	-	-	1	2	1	1	2
CO6	2	-	2	-	-	2	-	-	-	2	-	2	2	1
AVG	2.4	2	2	2	2	1.6				1.8	1.6	2	2	1.667

VIII. QUESTION BANK (JNTUH):

UNIT I

Long Answer Questions

S.No	**Question**	**Blooms Taxonomy Level**	**Course Outcome**
1	Explain the principle and operation of three phase induction motor?	Knowledge	1
2	A 4-pole induction motor, supplied by a slightly unbalanced three-phase 50 Hz source, is rotating at 1440 rpm. The electrical frequency in Hz of the induced negative sequence current in the rotor is?	Solving	3
3	Explain about the various losses occurring in a three phase induction motor?	Explain	2
4	A three-phase 440 V, 6 poles, 50 Hz, squirrel cage induction motor is running at a slip of 5%. The speed of stator magnetic field to rotor magnetic field and speed of rotor with respect of stator magnetic field are?	Solving	2
5	Derive the torque equation of three phase induction motor?	Derive	2

6	A three-phase squirrel cage induction motor has a starting torque of 150% and a maximum torque of 300% with respect to rated torque at rated voltage and rated frequency. Neglect the stator resistance and rotational losses. The value of slip for maximum torque is?	Applying	3
7	Draw the torque slip characteristics of three phase induction motor?	Explain	2
8	A three phase squirrel cage induction motor has a starting current of seven times the full load current and full load slip of 5% if an auto transformer is used for reduced voltage starting to provide 1.5 per unit starting torque, the auto transformer ratio (%) should be?	Determine	3
9	Derive the condition for maximum torque in a three phase induction motor?	Find	1
10	A 3 phase, 50 Hz, six pole induction motor has a rotor resistance of 0.1 Ω and reactance of 0.92 Ω. Neglect the voltage drop in stator and assume that the rotor resistance is constant. Given that the full load slip is 3%, the ratio of maximum torque to full load torque is?	Analyzing	4

Short Answer Questions

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	What are the two types of 3-phase induction motors? Which type is generally preferred?	Knowledge	2
2	Why induction motors are called "asynchronous"?	Understand	2
3	Why the air-gap between stator core and rotor of an induction motor is made very small?	Understand	1
4	Which type of induction motor develops higher starting torque?	Knowledge	2
5	What is the condition for maximum torque?	Knowledge	2
6	Define the slip?	Understand	1
7	What is the slip of induction generator?	Understand	1
8	When the slip is greater than one	Knowledge	1
9	Why semi closed type slots are prepared in induction motor?	Understand	2
10	What is the rotor frequency?	Understand	1

UNIT II

Long Answer Questions

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Explain about the speed control of three phase induction motor?	Explain	2
2	A 400 V, 50 Hz 30 hp, three-phase induction motor is drawing 50 A current at 0.8 power factor lagging. The stator and rotor copper losses are 1.5 kW and 900 W respectively. The friction and wind age losses are 1050 W and the core losses are 1200	Evaluating	5

	W. The air-gap power of the motor will be?		
3	Explain about starting methods of a three phase induction motor?	Understand	2
4	A balanced three-phase voltage is applied to a star-connected induction motor, the phase to neutral voltage being *V*. The stator resistance, rotor resistance referred to the stator, stator leakage reactance, rotor leakage reactance referred to the stator, and the magnetizing reactance are denoted by r_s, r_r, x_s ,x_r and x_m , respectively. The magnitude of the starting current of the motor is given by	Simplify	4
5	Explain about the construction of circle diagram and from that explain how to find the performance of three phase induction motor?	Explain	2
6	A three-phase squirrel cage induction motor has a starting torque of 150% and a maximum torque of 300% with respect to rated torque at rated voltage and rated frequency. Neglect the stator resistance and rotational losses. The value of slip for maximum torque is	Determine	5
7	Explain about the working principle of induction generator?	Understand	2
8	A three phase squirrel cage induction motor has a starting current of seven times the full load current and full load slip of 5% if an auto transformer is used for reduced voltage starting to provide 1.5 per unit starting torque, the auto transformer ratio (%) should be?	Apply	3
9	Define slip and slip speed of a three phase induction motor?	Define	1
10	A three phase squirrel cage induction motor has a starting current of seven times the full load current and full load slip of 5% If a star-delta starter is used to start this induction motor, the per unit starting torque will be?	Simplify	4

Short Answer Questions

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	1. Why an induction motor cannot run at synchronous speed?	Knowledge	1
2	2. What is slip of an induction motor?	Knowledge	1
3	3. A 3-phase, 50 Hz squirrel cage induction motor runs at 4% slip. What will be the frequency of rotor currents?	Understand	2
4	4. What is the speed of rotor mmf of a 3-phase induction motor w.r.t. its stator mmf?	Understand	2
5	5. At what slip the torque developed in an induction motor will be maximum?	Understand	2
6	6. What is the relationship of developed torque of a 3-phase induction motor with the supply voltage?	Understand	1
7	7. Speed of a 3-phase induction motor is varied by varying the supply frequency while v/f is kept constant. How will the maximum torque vary?	Understand	2
8	8. How is the mechanical power output represented in the circuit model of an induction motor?	Knowledge	1

9	9. What measure can be taken for minimizing the effect of crawling?	Knowledge	1
10	10. Why the power factor of an induction motor is low at starting?	Understand	2
11	11. Why an induction motor cannot run at synchronous speed?	Knowledge	1
12	12. What is slip of an induction motor?	Understand	2

UNIT III
Long Answer Questions

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	(a) Explain the operation of alternator on various loads for various power factors loads. (b) A 3phase alternator has 2 slots/pole/phase and coil span of 5 slot as full pitch	Understanding	3
2	(a) Derive the expression for per phase EMF induced in a 3phase alternator? Explain the factors affecting the value of EMF induced. (b) Give the winding details for a 3phase armature winding with following details: Pole = 4, Number of slots = 30, Double layer winding.	Knowledge	3
3	(a) What are harmonics? Explain how harmonics are present in generated emf of alternator? What are the effects of harmonics on generated emf? (b) A star connected 3 phase alternator has an induced emf of 400 V between the lines. Due to presence of third harmonic component the phase voltage is 244 V. Find the value of third harmonic voltage?	Knowledge	3
4	What are the effects of hunting on the performance of synchronous motor and explain the method of suppressing the hunting	Applying	3
5	Draw the phasor diagram of a loaded alternator for the following conditions: (a) Lagging p.f (b) Leading p.f. (c) Unity p.f.		
6	Explain the effect of armature reaction on the performance of an alternator. How it depends on the load pf.? Explain with suitable diagrams.	Understand	2
7	The stator of a 3-phase, 8-pole, and 750 r.p.m. alternator has 72 slots, each of which contains 10 conductors. Calculate the r.m.s. value of the e.m.f. per phase if the flux per pole is 0.1 Wb sinusoid ally distributed. Assume full-pitch coils and a winding distribution factor of 0.96.	Analyze	4
8	Find the regulation by the zero power factor method of 5 kVA, 6.6 kV, 3-phase, 50 Hz star-connected alternator at full load, unity power factor having the following test data: Field current in amperes: 32 | 60 | 75 | 100 | 140	Apply	3

OC test terminal voltage in volts	3100	4900	6600	7500	8300
Full load current zero pf tests line voltage in volts	0	1850	4250	5800	7000

9	Define voltage regulation of an alternator. Explain the various factors which may affect the regulation of an alternator.	Define	1
10	Explain how open-circuit and short-circuit tests are conducted on a synchronous machine. What is an air-gap line?	Explain	2
11	Explain the synchronous impedance method of determining the voltage regulation of an alternator. Comment on the merits and limitations of this method. Why this method is considered as pessimistic method?	Understand	2
12	Explain the MMF method of determining the voltage regulation of alternator.	Knowledge	1
13	Explain the Potier-triangle method of determining the voltage regulation of an alternator.	Understand	2
14	An l1-kV, 100o-kV A, three-phase, star-connected alternator has a resistance of 2 Ω per phase. The open-circuit curve and the characteristic with rated full-load current at zero power factor are .given in the following table. Find the voltage regulation of the alternator for full-load current at power factor of 0.8 lagging. Field Current (A)----40 50 110 140 180 Lime Volts ----5800 7000 12500 3750 15000 Lime volts zero p.f.----0 1500 8500 10550 12500	Apply	3
15	Describe the slip test method-for the measurement of X_d and X_q of synchronous machines.	Describe	4
16	Discuss Blondel's two-reaction theory of salient-pole synchronous machines.	Discuss	6
17	Draw and explain the phasor diagram of a salient-pole synchronous generator supplying a lagging power factor load.	Elaborate	6

Short Answer Questions

S.No	**Question**	**Blooms Taxonomy Level**	**Course Outcome**
1.	What type of rotor is adopted for high speed alternators?	Knowledge	1
2.	What will be the number of poles of a 50 Hz alternator if it runs at its greatest speed?	Knowledge	1
3.	What is the role of damper winding in synchronous generator and motor?	Understand	2
4.	What is the other name for distribution factor?	Knowledge	1
5.	Calculate the pitch factor of the following winding: 36 slots, 4 poles, coil span- 1to 8	Understand	2
6.	Can DC generator be converted into an alternator?	Knowledge	1
7.	What is meant by winding factor?		
8.	Defined pitch factor and distributed factor?	Define	1

9.	Why alternator is rated in kVA rather than in kW?	Remember	
10.	What is synchronous reactance X_s	Remember	1
11.	Why are distributed windings preferred over concentrated windings?	Remember	1
12.	At what voltage is the field of an alternator usually excited?	Remember	1
13.	What is meant by armature reaction of a synchronous machine?	Remember	1
14.	What is the effect of armature reaction for an alternator for zero power factor lagging?	Remember	1
15.	What is the effect of armature reaction for an alternator for zero power factor leading?	Remember	1
16.	What is the effect of armature reaction for an alternator for unity power factor?	Remember	1
17.	Name the different methods of voltage regulation of alternator?	Remember	1
18.	Why are the short circuit characteristics of an alternator linear?	Remember	1
19.	Which method of regulation is called pessimistic and why?	Remember	1
20.	What is the potier triangle?	Remember	1
21.	What are the characteristics required for potier method of computing voltage regulation?	Remember	1
22.	Why an alternator with low value of SCR has lower stability?	Remember	1
23.	What are the losses take place in an alternator?	Remember	1
24.	What is name of the test to determine the Xd and Xq?	Remember	1
25.	What is the order of Xd and Xq?	Remember	1

UNIT IV
Long Answer Questions

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Derive an expression for power developed in a non salient pole alternator.	Derive	2
2	State the conditions necessary for paralleling alternators?	Recall	1
3	A 500 MVA, 3 phase, 6 pole, and 11 KV star connected alternator is running in parallel with other synchronous machine on 11000 V bus. The synchronous reactance of the machine is 5 per phase. Calculate the synchronizing power per mechanical degree at full load and 0.8 p.f. lagging.	Solve	3
4	What do you mean by synchronizing alternators? Describe any one method of synchronization	Remember	1
5	Explain the effects of varying excitation on armature current and power factor in a synchronous motor. Draw V and Λ curves.	Explain	2
6	Explain the effect of change in excitation on the parallel operation of two alternators.	Explain	2
7	Derive necessary equations for power developed in a synchronous motor.	Show	2
8	Explain different torques of a synchronous motor.	Understand	2
9	A synchronous generator operates on constant-voltage constant frequency bus bars. Explain the effect of variation of (a) excitation and (b) steam supply on power output, power factor, armature current and load angle of the	Solve	3

	machine. An 11 kV 3 phase star-connected synchronous generator delivers 4000 k V A at unit, power factor when running on constant voltage constant frequency bus bars. If the excitation is raised by 20%, determine the kV A and power factor at which the machine now works. The steam supply is constant and the synchronous reactance is 30 Ω/ phase. Neglect power losses and assume the magnetic circuit to be un-saturated.		
10	With neat diagram explain the operation of synchronous motor and justify statement `synchronous motor is not self-starting'.	Understand	2
11	Explain the V and inverted V curves of synchronous motor	Understand	2
12	Write a short notes on synchronous condenser	Illustrate	2
13	Draw the phasor diagram of synchronous motor	Develop	3
14	Calculate the synchronizing power in kilowatts per degree of mechanical displacement at full load for a 1000 kV A, 6600 V, 0.8 power factor, 50 Hz, 8-pole, star-connected alternator having a negligible resistance and a synchronous reactance of 60%.	Solution	3
15	A 500 kV A, 3-Phase, 6-pole, 11 kV star-connected alternator is running in parallel with other synchronous machines9ri 11000 V bus. The synchronous reactance of the machines is 5Ω per phase. Calculate the synchronizing power per mechanical degree at full load and 0.8 power factor lagging.	Solve	3
16	A 10 MV A, 3-phase alternator has an' equivalent short-circuits reactance of 20%. Calculate the synchronizing power of the armature per mechanical degree phase displacement when running in parallel with 10000 V, 50 Hz bus bars at 1500 r.p.m.	Determine	5

Short Answer Questions

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Why are alternators put in parallel?	Understand	2
2	What is hunting?	Understand	2
3	What are the conditions for parallel operation of alternators?	Knowledge	1
4	What are the two methods by which two alternators are put in parallel?	Understand	2
5	A machine with a large air-gap has a higher synchronizing power. Why?	Knowledge	1
6	What is the effect of increasing the steam admission to the prime mover connected to an alternator?	Understand	2
7	What is the effect of varying excitation of an alternator running in parallel with another alternator?	Knowledge	1
8	What is meant by infinite bus-bars?	Applying	3
9	A synchronous motor develops some mechanical power, even if the field is unexcited. Is it cylindrical or salient pole machine?	Understand	2
10	Compare the salient pole rotor and cylindrical rotor synchronous motor, which is more stable?	Knowledge	1

11	What is meant by synchronous condenser?	Applying	3
12	What is the use of synchronous condenser?	Understand	1
13	What is meant by hunting of synchronous motor? How will you minimize it?	Remember	1
14	What are the advantages of synchronous motors?	Remember	1
15	What could be the reasons if a 3-phase synchronous motor fails to start?	Remember	1
16	A synchronous motor develops some mechanical power, even if the field is unexcited. Is it cylindrical or salient pole machine?	Explain	2

UNIT V
Long Answer Questions

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Explain the operation of a single phase induction motor using split phase technique	Extend	2
2	Show that the self-starting torque of a single phase induction motor is zero	Show	2
3	Explain two field revolving theory for single phase induction motor and give its Torque slip characteristic.	Explain	2
4	Using double field revolving field theory explain the torque slip characteristic of a single phase induction motor and prove that it can't produce starting torque.	Apply	3
5	The following test results were obtained in case of a 230 V single phase induction motor: Free running test: 230V, 0.5 A, pf 0.18 lagging Blocked rotor test: 58 V, 4.48 A, pf 0.58 lagging Determine the approximate equivalent circuit of motor. Assume: (a) Stator & rotor copper losses at standstill are equal (b) Rotor leakage reactance referred to the stator & stator leakage reactance are equal	Examine	4
6	What is split phase motor? Give the significance of split phase?	Remember	1
7	Draw the circuit diagram of 1-phase capacitor start and induction motor. Explain its working with all constructional details. Sketch the performance characteristics of the motor.	Examine	4
8	Explain shaded pole motor working priciple with neat circuit diagram?	Explain	2

Short Answer Questions

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Name the two theories regarding single phase induction motor?	List	1
2	What is a split phase motor?	Define	1
3	A single phase induction motor is provided with a main winding and an auxiliary winding. Which of these having more resistive.	Compare	2
4	How is the direction of rotation of a single phase induction motor reversed?	Find	1
5	Does the capacitor-start induction motor have a high or low	Tell	1

	starting torque?		
6	What is a shaded pole motor?	Remember	1
7	What is a universal motor?	Remember	1
8	Why compensating winding is provided in a universal motor for ac operation?	Remember	1
9	Which single phase motor has the poorest speed regulation?	Remember	1
10	Why the reluctance motor has low efficiency?	Remember	1

OBJECTIVE QUESTIONS:

UNIT I&II

JNTUH:

1) Purpose of oil in a transformer is
a) Cooling b) insulation c) both a&b d) none
2) As load changes flux in a transformer is
a) Increases b)Decreases c)Constant d)None

3) The L.V winding of a 400/230 single phase transformer is to be connected to a 25 Hz, the supply voltage should be?
a) 230 b)460 c) 115 d)65
4) A single phase transformer is to be switched to the supply to have minimum inrush current. The switch should be closed at
a) Maximum supply voltage b) zero supply voltge
c) 1/√2 max supply voltage d) 1/2 max supply voltage

IES

5) In transformer which of the following statement is valid?
a) In O.C test Copper losses are obtained while in S.C test core losses are obtained.
b) In O.C test, current drawn is drawn at high power factor.
c) In S.C test, current is drawn at zpf
d) In an O.C test current is drawn at upf
6) A three phase transformer has rating of 20 MVA, 220/33 KV star delta with leakage reactance of 12%. The transformer reactance in ohms referred to each phase of L.V delta connected side is?
a) 23.5 b)19.6 c)18.5 d)8.7

JNTUH:

7) The desirable property of transformer core material is?
a) Low permeability and low hysteresis loss
b) High permeability and high hysteresis loss
c) High permeability and low hysteresis loss
d) Low permeability and high hysteresis loss
8) The efficiency of two identical transformers under load can be determined by
a) O.C Test b) S.C Test c)Back to Back test d)Any of the above

GATE

9) Which of the following will improve the mutual coupling between primary and secondary windings?
a)Transformer oil of high breakdown strength
b) High reluctance magnetic core.
c)winding material of high resistivity
d)Low reluctance magnetic core
10) In a transformer if the iron loss and copper loss are 40.5Kw and 50 KW respectively, then at what fraction of load will the maximum efficiency will occur?
a)0.8 b)0.57 c)0.7 d)0.9

IES

11) If the frequency of input voltage of a transformer is increased, keeping the magnitude of voltage unchanged, then

a) Both eddy current and hysteresis loss will increase
b) Hysteresis loss will increase eddy current loss will decrease
c) Hysteresis loss will decrease, eddy current loss will increase
d) Hysteresis loss will decrease; eddy current loss will remain unchanged.

12) Two transformers when operating in parallel will share load depending upon?
a) Magnetizing current c) p.u impedance b) Leakage reactance d) efficiency

JNTUH:

13) A delta/delta transformer is connected to V/V transformer. The ratio of VA rating of V/V connected transformer and delta/delta connected transformer is
a)57.77% b)100% c)86.66% d)73.2%

14) A 200/100 50 HZ transformer is to be excited at 40 Hz from 100 V side. For the same exciting current the applied voltage should be?
a) 150 V b)80V c)100 V d)125V

GATE

15) When a transformer is first energized the transient current during first few cycles is
a) Less than full load current b) Equal to full load current
c) Equal to no load current d) much higher than full load current

16) A 25 KVA 2000/20, Two winding transformer is connected as auto transformer. The maximum possible KVA rating of AT is
a) 125 b) 275 c) 375 d) 175

IES

17) A single phase transformer has p.u resistance 0.2 and p.u reactance 0.6. Its p.u voltage regulation at 0.8 pf lagging would be?
a) 0.52 b) 0.42 c) 0.62 d) 0.36

18) A 230/2300 v star/delta three phase transformer is rated at 230 KVA. Its rated secondary current per phase is?
a) 33.33 A b)133.33 c) 66.66A d) 30.33

19) The following is the disadvantage of AT as compared to two winding transformer is?
a) Power rating is greater? b) Efficiency is low
c) Conductive isolation is not present. d) Voltage regulation is low.

UNIT III

1. Alternator operates on the principle of
a) electro-magnetic induction b) self-induction
c) Mutual induction d) b (or) c
Answer: A

2. In a synchronous machine, if the field flux axis is ahead of the armature field axis in the direction of rotation, the machine operating is
a) Synchronous motor b) Synchronous generator
c) Asynchronous motor d) Asynchronous generator
Answer: B

3. In small a.c. generators
a) Armature is revolving member
b) The magnet field is produced by d.c.electro-magnets placed on the stationary member
c) The current induced in the rotating armature is collected by means of brushes and slip-rings on the revolving member (rotor) d) All of the above.
Answer: A

4. In a.c. rotating machines, the generated e.m.f.,
a) is in phase with working flux ϕ b) leads ϕ by 90^0
c) lags ϕ by 90^0 d) lags ϕ by 180^0
Answer: C

5. The stator of an alternator gets overheated due to
a) Open phase b) unbalanced currents in the phases
c) Improper alignment of the rotor d) any one (or) more of the above
Answer: D

6. An exciter for an alternator is a small

a) d.c. series generator b) d.c. shunt generator
c) d.c. compound generator d) d.c. shunt (or) compound generator
Answer: B

7. In a large synchronous generator, dampers are provided in order to
a) Increase stability b) dominate harmonic effects
c) Reduce voltage fluctuations d) reduce frequency fluctuations
e) Both (a) and (b)
Answer: E

8. An alternator drive by a steam turbine is known as a
a) turbo-alternator b) hydro-generator
c) steam turbine d) none of the above
Answer: A

9. Turbo-alternators are generally employed to run at ________ r.p.m.
a) 500 b) 1000 c) 1500 d) 3000 e) 1500 (or) 3000
Answer: D

10. Hydro-generators are generally employed to run at _________ r.p.m.
a) 500 b) 1000 c) 1500 d) 3000
Answer: A

11. The high speed turbo-alternator has rotor of ____________ diameter and _______ axial length in comparison to those of rotor for a low speed hydro-generator.
a) smaller, smaller b) larger, smaller
c) smaller, larger d) larger, smaller
Answer: C

12. The rotor preferred for alternators applied to hydraulic turbines are _________ type. (Salient pole type)

13. Winding used for a.c. machines are ____________
a) open winding b) closed winding
c) semi-open winding d) semi-closed winding
Answer: A

14. Closed windings may be
a) Single layer b) Double layer
c) Both single layer and double layer d) All of these
Answer: A

15. A 3-pase machine has 48 slots and 10 poles. This machine can have ________ winding.
a) Integral-Slot winding b) Fractional Slot winding c) None of the above
Answer: B

16. To eliminate the 5^{th} harmonic from the e.m.f. generator in an alternator, the pitch factor will be ______________
a) 4/5 b) 5/4 c) 5/6 d) 6/5
Answer: A

17. In an alternator, the use of short pitch coils having pitch of 160^0 will eliminate _____________
a) 3^{rd} b) 5^{th} c) 7^{th} d) 9^{th}
Answer: D

18. Harmonics in the e.m.f. generated in an alternator can be reduced by
a) Skewing the slots b) Chamfering the salient pole tips
c) Using distributed winding d) All of the above
Answer: D

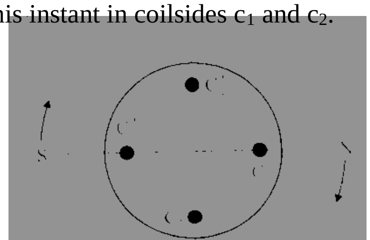
19. Chording and distribution of armature windings for a.c. machines results in
a) reduction in air gap mmf harmonics
b) reduction in fundamental component of induced e.m.f.
c) increase in fundamental component of induced e.m.f.
d) reduction in noise and machine size
e) both a and b
Answer: E

20. In an alternator, the armature reaction is considered to be equivalent to a fictitious
a) Reactance b) resistance c) impedance d) admittance
Answer: A

21. Drop in terminal voltage of an alternator due to armature reaction is counted by
    a) damper winding   b) effect of saliency
    c) increased prime-mover output   d) automatic voltage regulator
    Answer: A
22. Synchronous reactance of alternator represents
    a) armature reactance and leakage reactance
    b) a reactance operating at synchronous speed
    c) field winding reactance
    d) a reactance connected in series with a synchronous generator
    Answer: A
    a) 1.25 pu.   b) 1.11 pu.   c) 1.0 pu.   **d) 0.9 pu.**

GATE/IES PREVIOUS QUESTIONS

1. Distributed winding and short chording employed in AC machines will result in **GATE-2008**
   (a) Increase in emf and reduction in harmonics
   (b) Reduction in emf increase in harmonics
   (c) Increase in both emf and harmonics   (**d**) Reduction in both emf and harmonics
   Answer:D
2. A rotating electrical machine having its self-inductance of both the stator and the rotor windings, independent of the rotor position will be defiantly not develop **GATE-2004**
   (a) Starting torque   (b) Synchronizing torque
   (**c**) Hysteresis torque   (d) Reluctance torque
   Answer:C
3. Two magnetic poles revolve around a stationary armature carrying two coil (c_1– c'_1, c_2– c'_2) as shown in the figure. Consider the instant when the poles are in a position as shown. Identify the correct statement regarding the polarity of the induced emf at this instant in coilsides c_1 and c_2.



   (**a**) ⊙ in c_1, no emf in c_2 (b) ⊗ in c_1, no emf in c_2
   (c) ⊙ in c_2, no emf in c_1 (d) ⊗ in c_2, no emf in c_1
   Answer:A
4. A 100 kVA, 415 (line), star-connected synchronous machine generates rated open circuit voltage of 415 V at a field current of 15 A. The short circuit armature current at a field current of 10A is equal to the rated armature current. The per unit saturated synchronous reactance is **GATE-2007**
   (a) 1.731   (b) 1.5   (c) 0.666   (**d**) 0.577
   Answer:D
5. The synchronous speed for the seventh space harmonic mmf wave of a 3-phase, 8 pole, 50 Hz induction machine is **GATE-2004**
   (a) 107.14 rpm in forward direction
   (b) 107.14 rpm in reverse direction
   (c) 5250 rpm in forward direction
   (d) 5250 rpm in reverse direction
   Answer:A
6. A 500 MW 3-phase Y-connected synchronous generator has a rated voltage of 21.5 kV at 0.85 pf. The line current when operating at full load rated conditions will be **GATE-2004**

(a) 13.43 kA (b) 15.79 kA (c) 23.25 kA (d) 27.36 Ka

7. A synchronous generator is feeding a zero power factor (lagging) load at rated current. The armature reaction is **GATE-2006**

(a) Magnetizing **(b**) demagnetizing (c) cross-magnetizing (d) Non of the above

Answer:B

8. The two-bright and one dark lamp method is used for
   a. determination of phase sequence
   b. synchronizing of 3-phase alternators
   c. synchronizing of single phase alternators
   d. transfer of load
9. Desirable feature for successful parallel operation of two alternators is that both should have
   a) Same resistance b) Same reactance
   c**) High reactance in comparison to resistance**d) Low reactance in comparison to resistance
10. Synchronizing current means
    a. The total current supplied to the load by the alternators operating in parallel
    b. The current supplied by the synchronous generator
    c. The current circulating in the local circuit of two alternators operating in parallel which brings the alternators in synchronism once they are out of it.
    d. None of the above.
11. When two alternators are operating in proper synchronism, the synchronizing power will be
    a) Zero **b) Maximum**
    c) Minimum d) Sum of the output of the two alternators
12. If the voltage of one of the two machines operating in parallel suddenly falls
    a. both the machines will stop
    b. the machine whose voltage has suddenly decreased, will stop
    c. the **synchronous torque will come into operation to restore synchronism**
    d. None of the above.
13. Synchronizing torque will come into operation whenever
    a. There is a difference in the magnitude of voltages.
    b. There is a phase difference in the voltages.
    c. There is a frequency difference between the two voltages..
    d. Excitation of one of the alternators is changed.
    e. In all of the above cases.
14. If the excitation of one of the alternators operating in parallel is increased while keeping input to its prime-mover unchanged then the
    a. Reactive components of the output will change.
    b. active components of the output will change
    c. Power factors of the alternators will not change.
    d. kva supplied by the alternators will not change
15. Two alternators are operating in parallel. If the power input to the prime-movers of both the alternators is increased, this will affect change in
    a. generated emf
    b. frequency
    c. terminal voltage
    d. all of these
16. If the power input to an alternator operating in parallel with another alternator is increased keeping excitation constant, then
    a. it will share more load and relieve the other alternator of its load

- **b.** **the alternators will be out of synchronism**
- c. it will share less load
- d. the speed of the alternators will increase

17. Two alternators are operating in parallel and sharing a common load. For increasing the load shared by one of them
    - a. power input is kept constant and excitation is increased
    - **b.** **power input is kept constant and excitation is reduced**
    - c. power input is increased keeping excitation constant
    - d. power input is reduced keeping excitation constant
18. When two alternators are operating in parallel, if the power input to one of the alternators is cut-off, the alternator will
    - **a.** **continue to run as a synchronous motor rotating in the same direction**
    - b. continue to run as a synchronous motor rotating in the opposite direction
    - c. stop running
    - d. get damaged due to burning of stator and rotor windings
19. An infinite bus-bar has
    - a. constant voltage
    - b. constant frequency
    - c. infinite voltage
    - **d.** **both a and b**
    - e. both b and c
20. When two alternators are operating in parallel, if the power input to one of the alternators is cut-off, the alternator will
    - **a.** **Continue to run as a synchronous motor rotating in the same direction**
    - b. Continue to run as a synchronous motor rotating in opposite direction
    - c. Stop running
    - d. Get damaged due to burning of stator and rotor windings
21. A stationary alternator should not be connected to the live bus-bar because
    - a. it is likely to operate as a synchronous motor
    - b. it will get short-circuited
    - c. it will reduce bus-bar voltage
    - **d.** **all of the above**
22. An alternator connected to an infinite bus for a given excitation voltage, will develop maximum output power when the power angle δ and internal angle θ are related as

    a) $\delta = 180^0 - \theta$ b) $\delta = 90^0 - \theta$ c) **$\delta = \theta$** d) $\delta = 180^0 - 2\theta$

GATE/IES PREVIOUS QUESTIONS

1. A stand alone engine driven Synchronous generator is feeding a partly inductive load. A capacitor is now connected across the load to completely nullity the inductive current. For this operating condition.

GATE-2003

(a) The field current and fuel input have to be reduced.

(b) The field current & fuel input have to be increased.

(c) **The field current has to be increased & fuel input left unaltered.**

(d) The field current has to be reduced & fuel input left unaltered.

2. Two 3-phase, Y-connected alternators are to be paralleled to a set of common bus bars. The armature has a per phase synchronous reactance of 1.7 Ω and negligible armature resistance. The line voltage of the first machine is adjusted to 3300 V and that of the second machine is adjusted to 3200 V. The machine voltages are in phase at the instant they are paralleled. Under this condition, the synchronizing current per phase will be

GATE-2004

(a) 16.98 A (b) 29.41 A (c) 33.96 A (d) 58.82 A

UNIT IV &V

1. An electric motor in which both the rotor and stator fields rotate the same speed is called Synchronous motor.
2. The armature mmf in a synchronous motor aids the rotor mmf when the p.f. is Lagging
3. The maximum power in cylindrical and salient pole machine in obtained respectively at load angle of 90^0& less than 90^0
4. A salient pole synchronous motor is fed from infinite bus, and it is running at no load. If its field current is reduced to zero, then motor would _________________
   a) Stop b) run at a reduced speed
   c) Run at synchronous speed d) run above synchronous speed.
5. The angle between the synchronously rotating stator flux and rotor poles of a synchronous motor is called _____________ angle.
   a) Synchronizing b) **Torque**
   c) Power factor d) Slip
6. If load angle of a 4-pole synchronous motor is 8^0 (elect), its value in mechanical degrees is **4^0 mechanical**
7. Synchronous motor draws minimum current when the Power factor of the load is **UPF**
8. If the field of a synchronous motor is under excited, the power factor will be **Lagging pf**
9. An over excited synchronous motors draws currents at
   a) Lagging p.f b**) Leading p.f**
   c) Unity p,f d) Depends on the nature of the load.
10. With the increase in the excitation current of synchronous motor the power factor of the motor will be **increase and then decrease**
11. A synchronous motor on no-load can be used as synchronous condenser when the p.f. is **Leading**
12. A synchronous motor is running clockwise. If the direction of its field current is reversed, the motor would _____________
   a) Come to stop b) Run in the reversed
   c) Run in the same direction but at a slightly reduced speed.
   d**) Run in the same direction but at a slightly reduced speed.**
13. How do you reverse the direction of rotator on Synchronous motor?
14. The armature current of the synchronous motor has large values for ___________
   a) Low excitation only
   b) High excitation only
   c) B**oth high and low excitation**
15. In a 3-phase synchronous motor, the magnitude of field flux ,
   a) Varies with speed
   b) Varies with load
   c) **Remains constant at all loads**
   d) Varies with power factor
16. The locus of the armature current of a synchronous motor when the power developed is constant is **Semicircle**
17. A synchronous motor without D.C excitation is called **Induction** Motor.
18. For a salient pole type synchronous motor operating at lagging p.f, the excitation emf E is given by ___________________
   a) $V \cos \delta - I_d X_d$ (b) $V \cos \delta - I_a r_a - I_d X_d$

c) **$V \cos \delta - r_a I_q - I_d X_q$** (d) $V \cos \delta - r_a I_d - I_q X_d$

19. Why synchronous motors are not self-starting? **Due to Alternating torque**
20. In synchronous motor hunting is prevented by using **Damper winding**
21. A synchronous induction motor in normally fed with
    (a) A.C to stator and rotor (b) **A. C stator and D.C. to rotor**
    (c) D.C to stator and a.c to rotor. (d) Superimposed a.c and d.c to the stator.
22. For a given excitation, when the Power Circle touches the excitation circle, the power developed by a synchronous motor will be
    (**a) Maximum** (b) Minimum (c) Zero (d) None of the above

23. The radius of Power circle of synchronous motor with armature resistance? Phase operating with V volts across the lines and power developed in zero is
    a) V/ R_a b**) $V/ 2R_a$** c) 0 d) V/ 4Ra
24. When a 3-phase synchronous motor is driving a constant load torque and taking power from the infinite bus at leading p.f, if the excitation is increased then,
    (a) Armature current increases (b) Armature current decreases
    (c) **Armature current increases but p.f decreases.**
    (d) Armature current decreases but p.f increases.
25. A synchronous -induction motor
    a) St**arts as a synchronous motor but runs as an induction motor.**
    b) Starts as an induction motor but runs as synchronous motor
    c) Starts as an induction motor but runs at double the synchronous speed.
    d) Has the combined characteristics of synchronous motor and induction motor.

GATE/IES PREVIOUS QUESTIONS

Statement for Linked Answer Questions i and ii.

1. A synchronous motor is connected to an infinite bus at 1.0 pu voltage and draws 0.6 pu current at unity power factor. Its synchronous reactance is 1.0 pu and resistance is negligible. The excitation voltage (E) and load angle (δ) will respectively be **GATE-2008**
   (a) 0.8 pu and 36.86^0 lag (b) 08 pu and 36.86^0 lead
   (c) 1.17 pu and 30.96^0 load (d) 1.17 pu and 30.96^0 lag
2. Keeping the excitation voltage same, the load on the motor is increased such that the motor current increases by 20%. The operating power factor will become **GATE-2008**
   (a) 0.995 lagging (b**) 0.995 leading** (c) 0.791 lagging (d) 0.848 leading
3. 3. A 3 phase, 400 v, 5kW, star connected synchronous motor having an internal reactance of 10 Ω is operating at 50% load, unity pf. Now, the excitation is increased by 1%. What will be the new load in percent, if the power factor is to kept same? Neglect all lossed and consider linear magnetic circuit. **GATE-2006**
   (a) 67.9% (b) 56.9%
   (**c) 51%** (d) 50%
4. A three-phase synchronous motor connected to ac mains is running at full load unity power factor. If its shaft load is reduced by half, with field current held. constant, its new power factor will be **GATE-2007**
   (a) unity (b) leading
   (c) lagging (d) dependent on machine parameters

GATE/IES PREVIOUS QUESTIONS

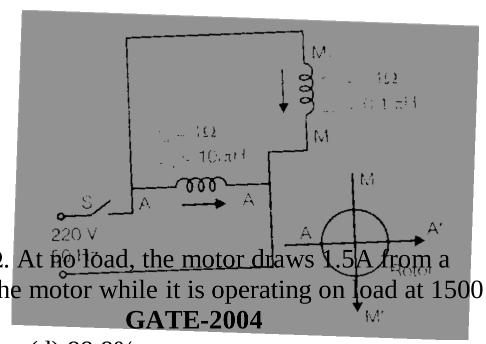
1. A single phase induction motor with only main winding excited would exhibit the following response at synchronous speed **GATE-2003**
   (a) Rotor current is zero

   (b) Rotor current is non-zero and is at slip frequency

(c) **Forward and backward totaling fields are equal**

(d) Forward rotating field is more than

2. The type of single-phase induction motor having the highest power factor at full load is **GATE-2004**
(a) shaded pole type (b) split-phase type
(c) capacitor-start type (d) **capacitor-run type**
3. For a single phase capacitor start induction motor which of the following statements is valid? **GATE-2006**
(a) The capacitor is used for power factor improvement
(b**) The direction of rotation can be changed by reversing the main winding terminals**.
(c) The direction of rotation cannot be changed
(d) The direction of rotation can be changed by interchanging the supply terminals.
4. A single-phase, 230 V, 50 Hz, 4 pole, capacitor-start induction motor has the following stand-still impedances
Main winding Z_m= 6.0 + j4.0 Ω
Auxiliary winding Z_a= 8.0 + j6.0 Ω The value of the starting capacitor required to produce 90^0 phase difference between the currents in the main and auxiliary windings will be **GATE-2004**
(a) 176.84 μF (b) 187.24 μF (c) **265.26 μF** (d) 280.86 μF
5. In a single phase induction motor driving a fan load, the reason for having a high resistance rotor is to achieve **GATE-2005**
(a) low starting torque (b**) quick acceleration**
(c) high efficiency (d) reduced size
6. 230 V, 50 Hz, 4 pole, single-phase induction motor is rotating in the clockwise (forward) direction at a speed of 1425 rpm. If the rotor resistance at standstill is 7.8Ω, then the effective rotor resistance in the backward branch of the equivalent circuit will be **GATE-2008**
(a) 2Ω (b**) 4Ω** (c) 78Ω (d) 156Ω
7. A 200 V, 50 Hz, single-phase induction motor has the following connection diagram and winding orientations shown. MM' is the axis of the main stator winding (M_1M_2) and AA' is that of the auxiliary winding (A_1A_2). Directions of the winding axis indicate direction of flux when currents in the windings are in the directions shown. Parameters of each winding are indicated. When switch S is closed, the motor **GATE-2009**



(a) Rotates clockwise
(b) Rotates anticlockwise
(c) Does not rotate
(d) Rotates momentarily and comes to a halt

8. The armature resistance of a permanent magnet dc motor is 0.8Ω. At no load, the motor draws 1.5A from a supply voltage of 25 V and runs at 1500 rpm. The efficiency of the motor while it is operating on load at 1500 rpm drawing a current of 3.5 A from the same source will be **GATE-2004**
(a) 48.0% (b) 57.1% (c) 59.2% (d) 88.8%
8. In a stepper motor, the detent torque means **GATE-2008**
(a) Minimum of the static torque with the phase winding excited.
(b) Maximum of the static torque with the phase winding excited.
(c) Minimum of the static torque with the phase winding unexcited.
(d)) **Maximum of the static torque with the phase winding unexcited**.
9. For a 1.8^0, 2-phase bipolar stepper motor, the stepping rate is 100 steps/second. The rotational speed of the motor in rpm is **GATE-2004**
(a) 15 (b**) 30** (c) 60 (d) 90
10. In relation to the synchronous machines, which one of the following statements is false? **GATE-2005**
(a) In salient pole machines, the direct- axis synchronous reactance is greater than the quadrature-axis synchronous reactance.

a. The damper bars help the synchronous motor self-start.

b. Short circuit ratio is the ratio of the field current required to produce the rated voltage onopen circuit to the rated armature current.

c. The V-curve of a synchronous motor represents the variation in

11. The armature current with field excitation, at a given output power 5.A 3ϕ, 3 stack, variable reluctance step motor has 20 poles on each rotor and stator stack. The step angle of this step motor is **GATE-2007**

(a) 3^0 (b**) 6^0** (c) 9^0 (d) 18^0

IX. WEBSITES:

1. www.jntuworld.com
2. http://nptel.ac.in/downloads/108105053/
3. http://uav.ece.nus.edu.sg/~bmchen/courses/EG1108_Transformers.pdf
4. http://*www.***iit***kgp.ernet.in/*
5. http://*www.***iit***k.ac.in/*
6. http://*www.***iit***b.ac.in/*
7. http://*www.***iit***d.ac.in/*

X. JOURNALS:

1. www.ieee.org
2. www.worldscientific.com
3. www.springer.com
4. www.sciencedirect.com

XI. LIST OF TOPICS FOR STUDENT SEMINARS:

1. Study of Losses &charactristics
2. Testing of Induction motor
3. Speed control of induction machines
4. Circle diagram construction

XII. CASE STUDIES/SMALL PROJECTS

1. Testing of transformer oil
2. Protection of transformer through relays
3. Speed control of induction motor