Department of Electrical & Electronics Engineering

Course File

BASIC ELECTRICAL ENGINEERING

(Course Code: EE204ES)

I B.Tech II Semester

2023-24

Yasoda Krishna Syameleti
Assistant Professor

ANURAG
Anurag
ENGINEERING COLLEGE
(An Autonomous Institution)
Ananthagiri, Kodad, Telangana 508 206, India.

Department of Electrical & Electronics Engineering

BASIC ELECTRICAL ENGINEERING

Check List

Department of Electrical & Electronics Engineering

Int. Marks:40 Ext. Marks:60 Total Marks:100

(EE204ES) BASICELECTRICALENGINEERING

I Year B.Tech. IT-II Sem

L-T-P-C
2-0-0-2

Unit-I:

D.C. Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Ohm's Law, KVL & KCL, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

Unit-II:

A.C. Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, realpower, reactive power, apparent power, powerfactor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series only), resonance in series R-L- C circuit. Three-phase balanced circuits, voltage and current relations in star and deltaconnections.

Unit-III:

Transformers: Ideal and practical transformer, equivalent circuit, losses in transformers, OC&SC teston transformers, regulation and efficiency. Condition for maximumefficiencyand applications.

Unit-IV:

Electrical Machines: Construction and working principle of dc machine, performance characteristics of dc shunt machine. Generation of rotating magnetic field, Construction and working of a three-phase induction motor, Significance of torque-slip characteristics. Single-phase induction motor, Construction and working. Construction and working of synchronous generator.

Unit-V:

Electrical Installations: Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics forBatteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

TextBooks:

1. D.P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill,4th Edition, 2019.

2. MS Naidu and S Kamakshaiah, "Basic Electrical Engineering", Tata McGrawHill, 2nd Edition, 2008.

ReferenceBooks:

1. P. Ramana, M. Suryakalavathi, G.T. Chandrasheker, "Basic Electrical Engineering", S. Chand, 2nd Edition, 2019.

2. D.C.Kulshreshtha,"BasicElectricalEngineering",McGrawHill,2009

3. M. S. Sukhija, T. K. Nagsarkar, "Basic Electrical and Electronics Engineering", Oxford, 1stEdition, 2012.

4. Abhijit Chakrabarthi, Sudipta Debnath, Chandan Kumar Chanda, "Basic Electrical Engineering", 2nd Edition, McGraw Hill, 2021.

5. L.S.Bobrow,"FundamentalsofElectricalEngineering",OxfordUniversityPress,2011.

6. E.Hughes,"ElectricalandElectronicsTechnology",Pearson,2010.

7. V.D.Toro,"ElectricalEngineeringFundamentals",PrenticeHallIndia,1989

Department of Electrical & Electronics Engineering

Timetable

I B.Tech. II Semester-BEE (IT&ECE)

Day/Hour	9.30-10.20	10.20-11.10	11.20-12.10	12.50-01.35	01.35-02.20	02.30-03.15	03.15-04.00
Monday					ECE	IT	
Tuesday			IT			ECE	
Wednesday				ECE	IT		
Thursday	ECE			IT			
Friday		ECE		IT			
Saturday							

Department of Electrical & Electronics Engineering

Vision of the Institute
To be a premier Institute in the country and region for the study of Engineering, Technology and Management by maintaining high academic standards which promotes the analytical thinking and independent judgment among the prime stakeholders, enabling them to function responsibly in the globalized society.

Mission of the Institute
To be a world-class Institute, achieving excellence in teaching, research and consultancy in cutting-edge Technologies and be in the service of society in promoting continued education in Engineering, Technology and Management.

Quality Policy
To ensure high standards in imparting professional education by providing world-class infrastructure, top-quality-faculty and decent work culture to sculpt the students into Socially Responsible Professionals through creative team-work, innovation and research

Vision of the Department
To impart technical knowledge and skills required to succeed in life, career and help society to achieve self sufficiency.

Mission of the Department
- To become an internationally leading department for higher learning.
- To build upon the culture and values of universal science and contemporary education.
- To be a center of research and education generating knowledge and technologies which lay groundwork in shaping the future in the fields of electrical and electronics engineering.
- To develop partnership with industrial, R&D and government agencies and actively participate in conferences, technical and community activities.

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Program Educational Objectives (B.Tech. – EEE)
Graduates will be able to

PEO 1: Have a successful technical or professional career, including supportive and leadership roles on multidisciplinary teams.
PEO 2: Acquire, use and develop skills as required for effective professional practices.
PEO 3: Able to attain holistic education that is an essential prerequisite for being a responsible member of society.

Program Outcomes (B.Tech. – EEE)
At the end of the Program, a graduate will have the ability to

PO 1: Apply knowledge of mathematics, science, and engineering.
PO 2: Design and conduct experiments, as well as to analyze and interpret data.
PO 3: Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
PO 4: Function on multi-disciplinary teams.
PO 5: Identify, formulates, and solves engineering problems.
PO 6: Understanding of professional and ethical responsibility.
PO 7: Communicate effectively.
PO 8: Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
PO 9: Recognition of the need for, and an ability to engage in life-long learning.
PO 10: Knowledge of contemporary issues.
PO 11: Utilize experimental, statistical and computational methods and tools necessary for engineering practice.
PO 12: Demonstrate an ability to design electrical and electronic circuits, power electronics, power systems; electrical machines analyze and interpret data and also an ability to design digital and analog systems and programming them.

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COURSE OBJECTIVES

On completion of this Subject/Course the student shall be able to:

S.No	Objectives
1	To introduce the concept of DC circuits and its components.
2	To impart the knowledge of AC circuits ,Phasor algebra related to alternating quantities
3	To introduce the concept of principle of operation of transformer.
4	To understand the knowledge about DC machines and Induction motors.
5	To import the knowledge of various electrical installation and the concept of power, power factor and its improvement.

COURSE OUTCOMES

The expected outcomes of the Course/Subject are:

S.No	Outcomes
1.	Understand the importance of DC circuits and analyze theorems.
2.	Understand the concept of AC circuits and resonance.
3.	Concept of principle of operation of transformer and efficiency of single phase transformer.
4.	Analyze the performance of DC machines and Induction motors.
5.	Demonstrate the importance of electrical installation and the concept of power, power factor and its improvement

Signature of faculty

Note: Please refer to Bloom’s Taxonomy, to know the illustrative verbs that can be used to state the outcomes.

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GUIDELINES TO STUDY THE COURSE / SUBJECT

Course Design and Delivery System (CDD):

- The Course syllabus is written into number of learning objectives and outcomes.
- Every student will be given an assessment plan, criteria for assessment, scheme of evaluation and grading method.
- The Learning Process will be carried out through assessments of Knowledge, Skills and Attitude by various methods and the students will be given guidance to refer to the text books, reference books, journals, etc.

The faculty be able to –

- Understand the principles of Learning
- Understand the psychology of students
- Develop instructional objectives for a given topic
- Prepare course, unit and lesson plans
- Understand different methods of teaching and learning
- Use appropriate teaching and learning aids
- Plan and deliver lectures effectively
- Provide feedback to students using various methods of Assessments and tools of Evaluation
- Act as a guide, advisor, counselor, facilitator, motivator and not just as a teacher alone

Signature of HOD   Signature of faculty

Date: Date:

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COURSE SCHEDULE

The Schedule for the whole Course / Subject is:

S. No.	Description	Duration (Date)		Total No. of Periods
		From	To	
1.	**Unit-I:** D.C. Circuits Electrical circuit elements (R, L and C), voltage and current sources, Ohm's Law, KVL & KCL, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.	05.02.2024	27.02.2024	18
2.	**Unit-II:** A.C. Circuits Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series only), resonance in series R-L- C circuit. Three-phase balanced circuits, voltage and current relations in star and delta connections.	28.02.2024	16.03.2024	14
3.	**Unit-III:** Transformers Ideal and practical transformer, equivalent circuit, losses in transformers, OC&SC test on transformers, regulation and efficiency. Condition for maximum efficiency and applications.	18.03.2024	20.04.2024	18
4.	**Unit-IV:** Electrical Machines Construction and working principle of dc machine, performance characteristics of dc shunt machine. Generation of rotating magnetic field, Construction and working of a three- phase induction motor, Significance of torque-slip characteristics. Single-phase induction motor, Construction and working. Construction and working of synchronous generator.	22.04.2024	10.05.2024	17
5.	**Unit-V:** Electrical Installations Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.	03.06.204	12.06.2024	08

Total No. of Instructional periods available for the course: 75 Hours

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SCHEDULE OF INSTRUCTIONS - COURSE PLAN

Unit No.	Lesson No.	Date	No. of Periods	Topics / Sub-Topics	Objectives & Outcomes Nos.	References (Textbook, Journal)
1.	1	05.02.2024	1	Introdution to Electrical Elements	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	2	06.02.2024	1	Electrical circuit elements(R,L,andC)	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	3	07.02.2024	1	voltage and current sources	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	4	08.02.2024	1	Types of Network Elements	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	5	09.02.2024	1	Ohms law	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	6	12.02.2024	1	KVL&KCL	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	7	13.02.2024	1	Analysis of simple circuits with dc excitation	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	8	14.02.2024	1	Mesh Analaysis	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	9	15.02.2024	1	Numerical Problems	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	10	16.02.2024	1	Nodal analaysis	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	11	17.02.2024	1	Superposition Theorem	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	12	19.02.2024	1	Thevenin's Theorem	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	13	20.02.2024	1	Numerical Problems	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	14	21.02.2024	1	Norton's Theorem	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath

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	15	22.02.2024	1	Numerical Problems	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	16	23.02.2024	1	Time response of series RL Circuit	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	17	24.02.2024	1	Numerical Problems	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	18	26.02.2024	1	Time response of series RC Circuit	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	19	27.02.2024	1	Numerical Problems	1 1	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
2.	1	28.02.2024	1	Representation of sinusoidal waveforms, peak, rms and average values	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	2	29.02.2024	1	Single-phase AC circuits consisting of R,L,C	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	3	01.03.2024	1	Series RL Circuit	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	4	02.03.2024	1	Series RC Circuit	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	5	04.03.2024	1	Series RLC Circuit	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	6	05.03.2024	1	Numerical Problems	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	7	06.03.2024	1	Power factor, real power, reactive power, apparent power	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	8	07.03.2024	1	Resonance concept (series circuit only)	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	9	11.03.2024	1	Three-phase balanced circuits in Star Connection	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	10	12.03.2024	1	Three-phase balanced circuits in Delta Connection	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	11	13.03.2024	1	Numerical Problems	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath

	12	14.03.2024	1	Numerical Problems	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	13	15.03.2024	1	Numerical Problems	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	14	16.03.2024	1	Numerical Problems	2 2	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
3.	1	18.03.2024	1	Introdution of Transformers	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	2	19.03.2024	1	Working Principle of singke phase Transformers	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	3	20.03.2024	1	Consrution of single phase transformer	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	4	21.03.2024	1	Ideal and practical single phase transformer	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	5	22.03.2024	1	Types of Transformers	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	6	23.03.2024	1	EMF Equation of single phase transformer	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	7	26.03.2024	1	Numerical Problems	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	8	27.03.2024	1	Numerical Problems	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	9	28.03.2024	1	Voltage Transformation Ratio	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	10	04.04.2024	1	Equivalent Circuit of single phase Transformer	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	11	06.04.2024	1	losses in single phase Transformer	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	12	08.04.2024	1	Open Circuit on single phase Transformer	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	13	10.04.2024	1	Short Circuit test on single phase Transformer	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath

	14	15.04.2024	1	regulation and efficiency	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	15	16.04.2024	1	Condition for maximum Effficiency	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	16	18.04.2024	1	Apllications of single phase Transformer	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	17	19.04.2024	1	Numerical Problems	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	18	20.04.2024	1	Numerical Problems	3 3	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
4	1	22.04.2024	1	Construction and Principle of Operation of DC Machine	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	2	23.04.2024	1	Types of DC Generators	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	3	24.04.2024	1	Numerical Problems	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	4	25.04.2024	1	Numerical Problems	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	5	26.04.2024	1	EMF Equation of DC Generator	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	6	27.04.2024	1	Numerical Problems	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	7	29.04.2024	1	Principle of Operation of DC Motor	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	8	30.04.2024	1	Torque Equation of DC Motor	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	9	01.05.2024	1	Numerical Problems	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	10	02.05.2024	1	Types of DC Motors	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	11	03.05.2024	1	Numerical Problems	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath

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	12	04.05.2024	1	Numerical Problems	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	13	06.05.2024	1	Magnetization and Load Characteristics of DC Generator	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	14	07.05.2024	1	Speed control of DC Shunt Motor	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	15	08.05.2024	1	Applications of DC Generators	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	16	09.05.2024	1	Applications of DC Motors	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	17	10.05.2024	1	Construction and Principle of operation of three phase Induction Motor	4 4	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
5	1	03.06.2024	1	Components of LT Switch gear	5 5	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	2	04.06.2024	1	Operation of MCB	5 5	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	3	05.06.2024	1	Types of wires,Cables	5 5	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	4	06.06.2024	1	Types of Batteries,Charecteristics	5 5	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	5	07.06.2024	1	Elementary calculations for Energy Consumption	5 5	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	6	10.06.2024	1	Power factor improvement	5 5	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	7	11.06.2024	1	Battery Backup	5 5	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath
	8	12.06.2024	1	Revision	1, 2, 3, 4, 5 1, 2, 3, 4, 5	Basic Electrical Engineering-D.P. Kothari and I. J. Nagrath

Signature of HOD — Signature of faculty

Date: — Date:

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Note:
1. Ensure that all topics specified in the course are mentioned.
2. Additional topics covered, if any, may also be specified in bold.
3. Mention the corresponding course objective and outcome numbers against each topic.

LESSON PLAN (U-I)

Lesson No: 01,02,03,04,05 Duration of Lesson: 50 min

Instructional / Lesson Objectives:

- To introduce the concept of DC circuits and its components.
- To impart the knowledge of AC circuits, Phasor algebra related to alternating quantities
- To introduce the concept of principle of operation of transformer
- To understand the knowledge about DC machines and Induction motors.
- To import the knowledge of various electrical installation and the concept of power, power factor and its improvement.

Teaching AIDS : PPTs, Digital Board
Time Management of Class :

5 mins for taking attendance
40 mins for the lecture delivery
5 min for doubts session

Assignment / Questions:
(Note: Mention for each question the relevant Objectives and Outcomes Nos.1,2,3,4 & 1,3..)

Signature of faculty

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Date	Day	Week No	Classes per week	Topics to be covered
5/Feb/24	MON	1	5	Introdution to Electrical Elements
6/Feb/24	TUE			Electrical circuit elements(R,L,andC)
7/Feb/24	WED			voltage and current sources
8/Feb/24	THU			Types of Network Elements
9/Feb/24	FRI			Ohms law
10/Feb/24	SAT			**Second Saturday**
11/Feb/24	SUN	**SUNDAY**		
12/Feb/24	MON	2	6	KVL&KCL
13/Feb/24	TUE			Analysis of simple circuits with dc excitation
14/Feb/24	WED			Mesh Analaysis
15/Feb/24	THU			Numerical Problems
16/Feb/24	FRI			Nodal analaysis
17/Feb/24	SAT			Superposition Theorem
18/Feb/24	SUN	**SUNDAY**		
19/Feb/24	MON	3	6	Thevenin's Theorem
20/Feb/24	TUE			Numerical Problems
21/Feb/24	WED			Norton's Theorem
22/Feb/24	THU			Numerical Problems
23/Feb/24	FRI			Time response of series RL Circuit
24/Feb/24	SAT			Numerical Problems
25/Feb/24	SUN	**SUNDAY**		
26/Feb/24	MON	4	6	Time response of series RC Circuit
27/Feb/24	TUE			Numerical Problems
28/Feb/24	WED			Representation of sinusoidal waveforms, peak, rms and average values
29/Feb/24	THU			Single-phase AC circuits consisting of R,L,C
1/Mar/24	FRI			Series RL Circuit
2/Mar/24	SAT			Series RC Circuit
3/Mar/24	SUN	**SUNDAY**		
4/Mar/24	MON	5	4	Series RLC Circuit
5/Mar/24	TUE			Numerical Problems
6/Mar/24	WED			Power factor, real power, reactive power, apparent power
7/Mar/24	THU			Resonance concept (series circuit only)
8/Mar/24	FRI			**Maha Shivaratri**
9/Mar/24	SAT			**Second Saturday**

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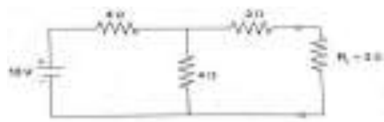
10/Mar/24	SUN	**SUNDAY**		
11/Mar/24	MON	6	6	Three-phase balanced circuits in Star Connection
12/Mar/24	TUE			Three-phase balanced circuits in Delta Connection
13/Mar/24	WED			Numerical Problems
14/Mar/24	THU			Numerical Problems
15/Mar/24	FRI			Numerical Problems
16/Mar/24	SAT			Numerical Problems
17/Mar/24	SUN	**SUNDAY**		
18/Mar/24	MON	7	6	Introdution of Transformers
19/Mar/24	TUE			Working Principle of singke phase Transformers
20/Mar/24	WED			Consrution of single phase transformer
21/Mar/24	THU			Ideal and practical single phase transformer
22/Mar/24	FRI			Types of Transformers
23/Mar/24	SAT			EMF Equation of single phase transformer
24/Mar/24	SUN	**SUNDAY**		
25/Mar/24	MON	8	4	**Holi**
26/Mar/24	TUE			Numerical Problems
27/Mar/24	WED			Numerical Problems
28/Mar/24	THU			Voltage Transformation Ratio
29/Mar/24	FRI			**Good Friday**
30/Mar/24	SAT			Numerical Problems
31/Mar/24	SUN	**SUNDAY**		
1/Apr/24	MON	9	2	**I Mid Examinations**
2/Apr/24	TUE			**I Mid Examinations**
3/Apr/24	WED			**I Mid Examinations**
4/Apr/24	THU			Equivalent Circuit of single phase Transformer
5/Apr/24	FRI			**Babu Jagjivan Ram Jayanthi**
6/Apr/24	SAT			losses in single phase Transformer
7/Apr/24	SUN	**SUNDAY**		
8/Apr/24	MON	10	2	Open Circuit on single phase Transformer
9/Apr/24	TUE			**Ugadi**
10/Apr/24	WED			Short Circuit test on single phase Transformer
11/Apr/24	THU			**Ramzan**
12/Apr/24	FRI			**Ramzan**
13/Apr/24	SAT			**Second Saturday**
14/Apr/24	SUN	**SUNDAY**		
15/Apr/24	MON	11	5	regulation and efficiency
16/Apr/24	TUE			Condition for maximum Effficiency

17/Apr/24	WED			**Ram Navami**
18/Apr/24	THU			Apllications of single phase Transformer
19/Apr/24	FRI			Numerical Problems
20/Apr/24	SAT			Numerical Problems
21/Apr/24	SUN	**SUNDAY**		
22/Apr/24	MON	**12**	**6**	Construction and Principle of Operation of DC Machine
23/Apr/24	TUE			Types of DC Generators
24/Apr/24	WED			Numerical Problems
25/Apr/24	THU			Numerical Problems
26/Apr/24	FRI			EMF Equation of DC Generator
27/Apr/24	SAT			Numerical Problems
28/Apr/24	SUN	**SUNDAY**		
29/Apr/24	MON	**13**	**6**	Principle of Operation of DC Motor
30/Apr/24	TUE			Torque Equation of DC Motor
1/May/24	WED			Numerical Problems
2/May/24	THU			Types of DC Motors
3/May/24	FRI			Numerical Problems
4/May/24	SAT			Numerical Problems
5/May/24	SUN	**SUNDAY**		
6/May/24	MON	**14**	**5**	Magnetization and Load Characteristics of DC Generator
7/May/24	TUE			Speed control of DC Shunt Motor
8/May/24	WED			Applications of DC Generators
9/May/24	THU			Applications of DC Motors
10/May/24	FRI			Construction and Principle of operation of three phase Induction Motor
11/May/24	SAT			**Second Saturday**
12/May/24	SUN	**SUNDAY**		
13/May/24	to 02-06-2024			**Summer vacation**
3/Jun/24	MON	**15**	**5**	Components of LT Switch gear
4/Jun/24	TUE			Operation of MCB
5/Jun/24	WED			Types of wires,Cables
6/Jun/24	THU			Types of Batteries,Charecteristics
7/Jun/24	FRI			Elementary calculations for Energy Consumption
8/Jun/24	SAT			**Second Saturday**
9/Jun/24	SUN	**SUNDAY**		
10/Jun/24	MON	**18**	**3**	Power factor improvement
11/Jun/24	TUE			Battery Backup
12/Jun/24	WED			Revision
18-06-2024 to 20-06-2024				**II Mid Examinations**

Department of Electrical & Electronics Engineering

ASSIGNMENT – 1

Question No.	Question	Objective No.	Outcome No.
1	State and Explain Super position theorem with one example.	1	1
2	Find the current flowing through the Load resistance by using Norton's theorem. 	1	1
3	Define RMS value and average value of an alternating quantity and Derive the Impedance of series R-C series circuit and draw the Impedance diagram.	2	2
4	Derive the necessary equations for line voltages and line currents in 3-Φ Balanced Star and Delta connected system.	2	2
5	State and Explain Faraday's Law of Electromagnetic Induction.	3	3

Signature of HOD

Date:

Signature of faculty

Date:

ANURAG Anurag ENGINEERING COLLEGE (An Autonomous Institution)

Department of Electrical & Electronics Engineering

ASSIGNMENT – 2

<table>
<tr><th>Question No.</th><th>Question</th><th>Objective No.</th><th>Outcome No.</th></tr>
<tr><td>1</td><td>a) Explain the construction details of DC generator?
b) A single-phase, 25Hz transformer has 50 primary turns and 600 secondary turns. The cross sectional area of the core is 400 sq.cm. If the primary of the Transformer is connected to a 50 HZ supply at 230 V. Find peak flux density and secondary induced voltage.</td><td>3</td><td>3</td></tr>
<tr><td>2</td><td>a) Derive an Emf Equation of DC generator.
b) A 8- pole generator having wave-wound armature winding has 72 slots, each slot containing 40 conductors. What will be the voltage generated in the machine when driven at 1700 rpm assuming the flux per pole to be 5.0 mWb ?</td><td>4</td><td>4</td></tr>
<tr><td>3</td><td>Sketch the Torque-slip characteristics of Induction motor and explain.</td><td>4</td><td>4</td></tr>
<tr><td>4</td><td>What are the different types of wires and cables? Explain.</td><td>5</td><td>5</td></tr>
<tr><td>5</td><td>Calculate the monthly Energy Consumption and Electricity Bill. Assume the electricity rate as 5.00rs per unit.
<table>
<tr><th>S. No.</th><th>Appliance name</th><th>No.</th><th>Rating in watts/unit</th><th>Operation time</th></tr>
<tr><td>1</td><td>Tubelights</td><td>3</td><td>40</td><td>6 hours</td></tr>
<tr><td>2</td><td>PL lamp</td><td>2</td><td>20</td><td>1 hour</td></tr>
<tr><td>3</td><td>Window type A/C</td><td>2</td><td>2000</td><td>4 hours</td></tr>
<tr><td>4</td><td>Domestic exhaust fan</td><td>1</td><td>100</td><td>3 hours</td></tr>
<tr><td>5</td><td>Toaster</td><td>1</td><td>750</td><td>15 mins</td></tr>
<tr><td>6</td><td>165 litre fridge</td><td>1</td><td>150</td><td>24 hours</td></tr>
</table>
</td><td>5</td><td>5</td></tr>
</table>

Signature of HOD

Date:

Signature of faculty

Date:

TUTORIAL SHEET – 1

This tutorial corresponds to Unit No. 1 (Objective Nos.: 1, Outcome Nos.: 1)

Q1. List the active elements?
a) resistor b) voltage c) Indutor d) Diode

Q2. Capacitance unit____
a) farads b) ohms c) henry d) Volts

Q3. Correct form of Ohm's Law.
a) V=IR b) R=VI c) R=I/V d) None

Signature of HOD

Date:

Signature of faculty

Date:

Department of Electrical & Electronics Engineering

TUTORIAL SHEET – 2

This tutorial corresponds to Unit No. 2 (Objective Nos.: 2, Outcome Nos.: 2)

Q1. The Power factor for pure resistive circuit
a) 0 b) 1 c) 0.9 d) None

Q2 peak value of Voltage Wave______
a) Vm b) Im c) 1 d) Pm

Q3. What is the Phase angle for pure resistor through the AC source
a) 1 b) 0 c) 0.5 d) 0.7

Signature of HOD

Date:

Signature of faculty

Date:

Department of Electrical & Electronics Engineering

TUTORIAL SHEET – 3

This tutorial corresponds to Unit No. 3 (Objective Nos.: 3, Outcome Nos.: 3)

Q1. Transformer core is made up of___

a) Copper b) Silicon Steel c) AL d) None

Q2 Transformer rating is in____
a) KW b) KVA c) KA d) KH

Q3. Transformer works on the principle of ______________
a) Mutual Flux b) Opposing Flux c) Leakage Flux d) Lenz's law

Signature of HOD Signature of faculty

Date: Date:

Department of Electrical & Electronics Engineering

TUTORIAL SHEET – 4

This tutorial corresponds to Unit No. 4 (Objective Nos.: 3, Outcome Nos.: 3)

Q1. The armature of DC motor is laminated to ____________
a) To reduce mass b) To reduce hysteresis loss
c) To reduce eddy current loss d) To reduce inductance

Q2. Number of parallel paths in wave winding are ______
a)Equal to P b) Equal to P/2 c) 2 d) Depends on other parameters

Q3. Direction of rotation of motor is determined by ____________
a) Faraday's law b) Lenz's law c) Coulomb's law d) Fleming's left-hand rule

Signature of HOD

Date:

Signature of faculty

Date:

Department of Electrical & Electronics Engineering

TUTORIAL SHEET – 5

This tutorial corresponds to Unit No. 5 (Objective Nos.: 5, Outcome Nos.: 5)

Q1. What does “MCB” stand for?
a) Miniature circuit breaker b) Mini circuit breaker
c) Miniature capacitor breaker d) Mini Capacitance breaker

Q2. Which of the following is not a requirement for a useful battery?

a) It should be light and compact b) It should have a reasonable life span
c) It should ideally have a constant voltage throughout its lifespan
d) It should supply Alternating Current(AC)

Q3. Which one of the following is the practical unit of power?
a) Watt (W) b) Kilowatt hour (kWh) c) Horse power (hp) d) Kilojoule (kJ)

Signature of HOD Signature of faculty

Date: Date:

Department of Electrical & Electronics Engineering

EVALUATION STRATEGY

Target (s)

a. Percentage of Pass : 95%

Assessment Method (s) (Maximum Marks for evaluation are defined in the Academic Regulations)

a. Daily Attendance
b. Assignments
c. Online Quiz (or) Seminars
d. Continuous Internal Assessment
e. Semester / End Examination

List out any new topic(s) or any innovation you would like to introduce in teaching the subjects in this semester

Case Study of any one existing application

Signature of HOD

Date:

Signature of faculty

Date:

Department of Electrical & Electronics Engineering

COURSE COMPLETION STATUS

Actual Date of Completion & Remarks if any

Units	Remarks	Objective No. Achieved	Outcome No. Achieved
Unit 1	completed on 27.02.2024	1	1
Unit 2	completed on 16.03.2024	2	2
Unit 3	completed on 20.04.2024	3	3
Unit 4	completed on 10.05.2024	4	4
Unit 5	completed on 12.06.2024	5	5

Signature of HOD

Date:

Signature of faculty

Date:

Department of Electrical & Electronics Engineering

Mappings

1. Course Objectives-Course Outcomes Relationship Matrix

(Indicate the relationships by mark "X")

Course-Objectives \ Course-Outcomes	1	2	3	4	5
1	H		M		
2		H			
3			H		
4				H	
5					H

2. Course Outcomes-Program Outcomes (POs) & PSOs Relationship Matrix

(Indicate the relationships by mark "X")

C-Outcomes \ P-Outcomes	a	b	c	d	e	f	g	h	i	j	k	l	PSO 1	PSO 2
1	H			M									H	
2		M	H			M							H	H
3					H				M		M			M
4						M	H						M	
5										H				

Department of Electrical & Electronics Engineering

Rubric for Evaluation

Performance Criteria	Unsatisfactory	Developing	Satisfactory	Exemplary
	1	**2**	**3**	**4**
Research & Gather Information	Does not collect any information that relates to the topic	Collects very little information some relates to the topic	Collects some basic Information most relates to the topic	Collects a great deal of Information all relates to the topic
Fulfill team role's duty	Does not perform any duties of assigned team role.	Performs very little duties.	Performs nearly all duties.	Performs all duties of assigned team role.
Share Equally	Always relies on others to do the work.	Rarely does the assigned work - often needs reminding.	Usually does the assigned work - rarely needs reminding.	Always does the assigned work without having to be reminded
Listen to other team mates	Is always talking—never allows anyone else to speak.	Usually doing most of the talking-- rarely allows others to speak.	Listens, but sometimes talks too much.	Listens and speaks a fair amount.

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www.anurag.ac.in +91 9963122270

I B.TECH II SEMESTER I MID EXAMINATIONS - APRIL 2024

Branch : B.Tech. (ECE) & (IT) **Max. Marks 30M**
Date : 02 - Apr - 2024 **Time : 120**
Subject : Basic Electrical Engineering,EE204ES

PART - A

ANSWER ALL QUESTIONS **10 X 1M =10M**

Q.No	Question		CO	BTL
1.	List the passive elements? (A). resistor (B). voltage (C). current (D). Battery	( )	CO1	L1
2.	Capacitance unit____ (A). farads (B). ohms (C). henry (D). Volts	( )	CO1	L1
3.	Resistance unit____ (A). farads (B). ohms (C). henry (D). Volts	( )	CO1	L1
4.	List the active elements? (A). resistor (B). voltage (C). indutor (D). Diode	( )	CO1	L1
5.	What is value of peakfactor for sinusoidal wave? (A). 1.11 (B). 0 (C). 1.414 (D). 1	( )	CO2	L1
6.	What is the Phase angle for pure resistor through the AC source (A). 1 (B). 0 (C). 0.5 (D). 0.7	( )	CO2	L1
7.	What is value of formfactor for sinusoidal wave? (A). 1.11 (B). 0 (C). 1.414 (D). 1	( )	CO2	L1
8.	An R-L circuit with R=20 and XL= 15 Find the power factor of the circuit? (A). 0.9 (B). 0.8 (C). 1 (D). 0.95	( )	CO2	L2
9.	Lenz's Law States_____ (A). Mutual Flux (B). Opposing Flux (C). Leakage Flux (D). None	( )	CO3	L1
10.	Transformer core is made up of___ (A). Copper (B). Slicon Steel (C). AL (D). None	( )	CO3	L1

Department of Electrical & Electronics Engineering

PART - B

ANSWER ANY FOUR 4 X 5M =20M

Q.No	Question	CO	BTL
11.	Derive the equivalent resistance when the resistors are connected i) Series ii) Parallel	CO1	L2
12.	Explain the Time domain analysis of series RC Circuit	CO1	L3
13.	A resistance of 12, inductance of 0.15H, capacitance of 100μF are connected in series across 100V,50HZ supply. calculate 1)impedance 2)current 3)power factor 4)power consumed.	CO2	L3
14.	Derive the Impedance of series RL Circuit and draw the impedance diagram.	CO2	L3
15.	A single phase transformer has 350 primary and 1,050 secondary turns. The net cross-sectional area of the core is 55 cm2. If the primary winding be connected to a 400 V, 50 Hz single phase supply, calculate (i) maximum value of the flux density in the core and (ii) the voltage induced in the secondary winding.	CO3	L3
16.	Explain the construction and working principle of Single phase Transformer	CO3	L3

Department of Electrical & Electronics Engineering

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I B.TECH II SEMESTER II MID EXAMINATIONS - JUNE 2024

Branch : B.Tech. ECE & IT **Max. Marks : 30M**
Date : 19-Jun-2024 Session : Morning **Time : 120 Min**
Subject : Basic Electrical Engineering,EE204ES

PART - A

ANSWER ALL THE QUESTIONS **10 X 1M = 10M**

Q.No	Question		CO	BTL
1.	Open circuit test on transformers is conducted so as to get ____________ (A). Hysteresis losses (B). Copper losses (C). Core losses (D). Eddy current losses	( )	CO3	L1
2.	An ideal transformer will have maximum efficiency at a load such that ____________ (A). copper loss > iron loss (B). cannot be determined (C). copper loss = iron loss (D). copper loss < iron loss	( )	CO3	L1
3.	What will happen, with the increase in speed of a DC motor? (A). Back emf increase but line current falls. (B). Back emf falls and line current increase. (C). Both back emf as well as line current increase. (D). Both back emf as well as line current fall.	( )	CO4	L2
4.	What is Self-excitation in DC shunt generator? (A). Field winding is connected in series of armature (B). Field winding is connected in parallel of armature (C). Field winding is not connected to the armature (D). Field Winding is not excited	( )	CO4	L2
5.	The armature of DC motor is laminated to ____________ (A). To reduce mass (B). To reduce hysteresis loss (C). To reduce eddy current loss (D). To reduce inductance	( )	CO4	L1
6.	Direction of rotation of motor is determined by ____________ (A). Faraday's law (B). Lenz's law (C). Coulomb's law (D). Fleming's left-hand rule	( )	CO4	L1
7.	Which of the following energy is converted to electricity by the battery? (A). Mechanical energy (B). Chemical energy (C). Thermal energy (D). Electrical energy	( )	CO5	L1

Department of Electrical & Electronics Engineering

8.	The SI unit of electrical energy is ____________ ( ) (A). kilojoule (KJ) (B). joules (J) (C). watt (W) (D). kilowatt (KW)		CO5	L1
9.	What is the principal on which MCB (Miniature circuit breaker) works ? ( ) (A). Magnetic effect of electric current (B). Lenz law (C). Faradays law of electric current (D). Flemings Right hand rule		CO5	L2
10.	Which of the following is not a requirement for a useful battery? ( ) (A). It should be light and compact (B). It should have a reasonable life span (C). It should ideally have a constant voltage throughout its lifespan (D). It should supply Alternating Current(AC)		CO5	L2

PART - B

ANSWER ANY FOUR **4 X 5M = 20M**

Q.No	Question	CO	BTL
11.	What are the different types of losses in transformer and also derive condition for maximum efficiency.	CO3	L3
12.	In a 100 kVA transformer, the iron loss is 450 W and full-load copper loss is 900 W. Find the transformer efficiency at full load and the maximum efficiency of the transformer, where the load power factor is 0.8 lagging.	CO3	L4
13.	Explain with suitable diagram how rotating magnetic field is produced in 3- induction motor.	CO4	L4
14.	What are the speed controlling methods in a DC motor and also write the applications.	CO4	L3
15.	Write the function of (i) Fuse (ii) Relay (iii) Circuit breaker.	CO5	L4
16.	Calculate the electricity bill amount for a month of 31 days, if the following devices are used as specified: a) 3 bulbs of 30 watts for 5 hours b) 4 tube lights of 50 watts for 8 hours c) 1 fridge of 300 watts for 24 hours Given the rate of electricity is 2 Rs. per unit.	CO5	L4

Department of Electrical & Electronics Engineering

Continuous Internal Assessment (R-22)

Programme: **BTech-IT** Year: **I** Course: **Theory** **A.Y: 2023-24**

Course: Basic Electrical Engineering Section: A Faculty Name: S.Yasoda Krishna

S. No	Roll No	MID-I (35M)	MID-II (35M)	Avg. of MID I & II	Viva-Voce/Poster Presentation (5M)	Total Marks (40)
1	23C11A1201	12	13	13	5	18
2	23C11A1202	10	0	5	AB	5
3	23C11A1203	35	34	35	5	40
4	23C11A1204	15	16	16	5	21
5	23C11A1205	19	12	16	5	21
6	23C11A1206	35	34	35	5	40
7	23C11A1207	35	23	29	5	34
8	23C11A1208	10	0	5	5	11
9	23C11A1209	30	23	27	5	32
10	23C11A1210	35	33	34	5	39
11	23C11A1211	15	24	20	5	25
12	23C11A1212	33	28	31	5	36
13	23C11A1213	35	35	35	5	40
14	23C11A1214	15	21	18	5	23
15	23C11A1215	32	34	33	5	38
16	23C11A1216	18	20	19	5	24
17	23C11A1217	7	5	7	5	12
18	23C11A1218	16	17	17	5	22
19	23C11A1219	15	20	18	5	23

20	23C11A1220	24	28	26	5	31
21	23C11A1221	35	34	35	5	40
22	23C11A1222	31	28	30	5	35
23	23C11A1223	33	29	31	5	36
24	23C11A1224	13	5	9	5	15
25	23C11A1225	35	26	31	5	36
26	23C11A1226	15	10	13	5	18
27	23C11A1227	33	31	32	5	37
28	23C11A1228	13	25	19	5	24
29	23C11A1229	18	20	20	5	25
30	23C11A1230	18	27	23	5	28
31	23C11A1231	31	29	30	5	35
32	23C11A1232	30	29	30	5	35
33	23C11A1233	15	17	16	5	21
34	23C11A1234	25	27	26	5	31
35	23C11A1235	7	5	6	5	12
36	23C11A1236	10	18	14	5	19
37	23C11A1237	35	30	33	5	38
38	23C11A1239	35	32	34	5	39
39	23C11A1242	35	34	35	5	40
40	23C11A1243	10	18	14	5	19
41	23C11A1244	17	13	15	5	20
42	23C11A1245	30	24	27	5	33
43	23C11A1246	34	30	32	5	37
44	23C11A1247	34	26	30	5	35
45	23C11A1248	18	12	15	5	20

46	23C11A1249	10	14	12	5	18
47	23C11A1250	25	30	28	5	33
48	23C11A1251	31	28	30	5	35
49	23C11A1252	25	20	23	5	28
50	23C11A1253	35	35	35	5	40
51	23C11A1254	30	26	28	5	33
52	23C11A1255	35	35	35	5	40
53	23C11A1256	14	14	14	5	19
54	23C11A1257	18	17	18	5	23
55	23C11A1259	22	20	21	5	26

No. of Absentees: **00**

Total Strength: **55**

Signature of Faculty

Signature of HoD

Department of Electrical & Electronics Engineering

Continuous Internal Assessment (R-22)

Programme: **BTech-ECE** Year: **I** Course: **Theory** **A.Y: 2023-24**

Course: Basic Electrical Engineering Section: A Faculty Name: S.Yasoda Krishna

S. No	Roll No	MID-I (35M)	MID-II (35M)	Avg. of MID I & II	Viva-Voce/Poster Presentation (5M)	Total Marks (40)
1	22C11A0406	22	22	22	5	27
2	22C11A0412	15	16	16	5	21
3	23C11A0401	31	26	29	5	34
4	23C11A0402	33	23	28	5	33
5	23C11A0403	15	24	20	5	25
6	23C11A0404	34	32	33	5	38
7	23C11A0405	19	20	20	5	25
8	23C11A0406	25	21	23	5	28
9	23C11A0407	14	26	20	5	25
10	23C11A0408	29	26	28	5	33
11	23C11A0409	25	21	23	5	28
12	23C11A0410	23	24	24	5	29
13	23C11A0411	25	24	25	5	30
14	23C11A0412	23	21	22	5	27
15	23C11A0413	30	35	33	5	38
16	23C11A0414	20	16	18	5	23
17	23C11A0415	24	23	24	5	29
18	23C11A0416	19	18	19	5	24
19	23C11A0417	33	31	32	5	37

20	23C11A0418	15	19	17	5	22
21	23C11A0419	26	25	16	5	31
22	23C11A0420	35	33	34	5	39
23	23C11A0421	17	20	19	5	24
24	23C11A0422	18	17	18	5	23
25	23C11A0423	18	23	21	5	26
26	23C11A0424	31	24	28	5	33
27	23C11A0425	31	33	32	5	37
28	23C11A0426	20	20	20	5	25
29	23C11A0427	29	25	27	5	32
30	23C11A0428	29	22	26	5	31
31	23C11A0429	25	23	24	5	29
32	23C11A0430	35	30	33	5	38
33	23C11A0431	32	27	30	5	35
34	23C11A0432	27	14	21	5	26
35	23C11A0433	24	19	22	5	27
36	23C11A0434	13	16	15	5	20
37	23C11A0435	15	23	19	5	24
38	23C11A0436	30	21	27	5	31
39	23C11A0437	34	21	28	5	33
40	23C11A0438	22	16	19	5	24
41	23C11A0439	30	24	27	5	32
42	23C11A0440	20	23	22	5	27
43	23C11A0441	33	28	31	5	36
44	23C11A0442	19	24	22	5	27
45	23C11A0443	11	14	13	5	18

46	23C11A0444	14	13	14	5	19
47	23C11A0445	15	18	17	5	22
48	23C11A0446	35	20	28	5	33
49	23C11A0447	15	19	17	5	22
50	23C11A0448	34	21	28	5	33
51	23C11A0449	15	5	10	5	15
52	23C11A0450	35	32	34	5	39
53	23C11A0451	35	34	35	5	40
54	23C11A0452	23	23	23	5	28
55	23C11A0453	21	23	22	5	27
56	23C11A0454	21	22	22	5	27
57	23C11A0455	35	34	35	5	40
58	23C11A0456	28	33	31	5	36
59	23C11A0457	35	35	35	5	40

No. of Absentees: **00**

Total Strength: **59**

Signature of Faculty

Signature of HoD

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Ananthagiri (V,& M), Kodad, Suryapet (Dist), Telangana.

Program			YEAR	SEMESTER	MID EXAMINATION
B.Tech. ✓	M.Tech.	M.B.A.	I	II	II

Regulation : R23 | Branch or Specialization: IT

HALL TICKET NO.: 2 3 C 1 1 A 1 2 3 7

Signature of Student: G. Pravallika

Course: BEE

Signature of invigilator with date: 19/6/24

Signature of the Evaluator:

Q.No. and Marks Awarded										
1	2	3	4	5	6	7	8	9	10	11

Maximum Marks: 30 | Marks Obtained: 25

(Start Writing From Here)

Part-B

11. There are 2 types of losses in a transformer. They are:

i. Copper losses (W_{cu})

ii. Iron losses (W_i).

Copper losses: These losses are exists of the windings of a transformer.

* Copper losses are also called as variable losses.
* In a transformer the winding of copper loss is "I".
* The primary winding of a copper loss is "I_1"
* The secondary winding of a copper loss is "I_2"

Total → $W_{cu} = I_1^2 + I_2^2$

* These losses change with respect to load.

Iron losses: These losses are exists of a

There are 2 types of losses in Iron losses:

i, Hystreresis losses

ii, Eddy Current losses.

Hystreresis Current losses:-

These are the losses produced in a transformer with magnetic flux, volume of core transistor

Eddy Current losses:-

These are the losses produced in a transformer by the square of magnetic flux, volume of core in transistor

Condition for maximum efficiency:-

$$W_{cu} = \frac{\text{output Current}}{\text{output Current} + \text{losses}}$$

$$W_i = \frac{I/P - \text{losses}}{I/P}$$

$$W_{cu} = \frac{I_2^2 R_2 \cos\phi_2}{I_2^2 R_2 \cos\phi_2 + W_i + R_2 I_2}$$

$$W_i = \frac{I_1^2 R_1 \cos\phi_1 - (W_i + R_1)}{I_1^2 R_1 \cos\phi_1}$$

$$\frac{d}{dI_2} \quad \frac{I_2 R_2 \cos\phi_2 (I_2 R_2 \cos\phi_2 + W_i + KI) - I_2 R_2 \cos\phi_2 + W_i + I (I_2^2 R_2 \cos\phi_2)}{(I_2^2 R_2 \cos\phi_2)^2}$$

$W_{cu} = I_2^2 R_2$

$\therefore$ Copper losses = Iron losses

5

12. Given that

$W_i = 450 W$

$W_{cu} = 900 W$

$\cos\phi = 0.8$

$$\eta = \frac{I_2^2 R_2 \cos\phi_2}{I_2^2 R_2 \cos\phi_2 + W_i + W_{cu}}$$

$$= \frac{100 \times 10^3 \times 0.8}{100 \times 10^3 \times 0.8 + 450 + 900} \times 100$$

$= 0.074\ \%$

$$\eta = \frac{100 \times 10^3 \times 0.8}{100 \times 10^3 \times 0.8 + 450 + 450} \times 100$$

$= 0.11\%$

3

Fuse :-

Fuse is a electrical device which used to stop the faulty current. When the current exceeds its limits fuse melts and causes damage. When the fuse gets damaged current doesn't flow in the circuit.

Relay :-

Relay is a switching device which is used in a current circuit. It stops the faulty current to flow in the circuit. It has many like make circuit, break circuit.

Circuit breaker :-

Circuit breaker is a switching device used in low voltage condition. It stops faulty current to flow in the circuit. Circuit breaker doesnot cause any damage. Instead of fuse nowadays we are using Miniature Circuit breaker (MCB). When the MCB switches falls down flowing of current stops and again we can on them. But MCB is more expensive than fuse.

Working of Circuit breaker

There are 2 contacts in circuit breaker
i. moving contact
ii, constant contact

Given that

31 days, rate of electricity = 2/- per unit

a) 3 bulbs of 30 watts for 5 hours

b) 4 tube lights of 50 watts for 8 hours

c) 1 fridge for 300 watts for 24 hours

a) i) $3 \times 30 \times 5 = 450$ kW

ii) $\frac{450}{1000} = 0.45$ W

iii) 0.45×31 days $= 13.95$ W

iv) $13.95 \times 2/- = 27.9$ ruppes

b) i) $4 \times 50 \times 8 = 1600$ kW

ii) $\frac{1600}{1000} = 1.6$ Watts

iii) 1.6×31 days $= 49.6$ W

iv) $49.6 \times 2 = 99.2$ ruppees.

c) i) $1 \times 300 \times 24 = 7200$ kW

ii) $\frac{7200}{1000} = 7.2$ W

iii) 7.2×31 days $= 223.2$

iv) $223.2 \times 2 = 446.4$ ruppees.

Total electricity bill amount = $27.9 + 99.2 + 223.2$

$= 350.3$ ruppes.

Part-A

1 C

2 C

3 A

4 D

5 C

6 D

7 A

8 C

9 C

10 C

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Ananthagiri (V & M), Kodad, Suryapet (Dist), Telangana.

Program		
B.Tech. ✓	M.Tech.	M.B.A.

YEAR	SEMESTER	MID EXAMINATION
I	II	II

Regulation : R22 Branch or Specialization: IT

HALL TICKET NO.

2	3	C	1	1	A	1	2	4	9

Signature of Student: Md Shoaib

Course: BEE

Signature of invigilator with date:

Q.No. and Marks Awarded

1	2	3	4	5	6	7	8	9	10	11

Signature of the Evaluator:

Maximum Marks	30	Marks Obtained	9

(Start Writing From Here)

PART-A.

1. B ✗
2. C ✓
3. A ✓
4. A ✗
5. C ✓
6. D ✓
7. B ✓
8. B ✓
9. A ✓

PART-B

11. There are different types of losses in transformers because of the there are multimeters in the other Chambers and the Voltage of the current not support the electricity of the Conductor and it is must be seperated in the multi and other meters and there are the equal valued meters are present because of it is have most powerful voltage in it's orbit.
The voltage of Current is applied to the Circuit and it is Seperated into the Voltmeter the process should be in the regular form of the Speed to maintain the equal and Constant value of maximum effiency.

12. Given data.
100KVA.

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Program			YEAR	SEMESTER	MID EXAMINATION
B.Tech ✓	M.Tech	M.B.A	I	II	II

Regulation: R23 | Branch or Specialization: ECE

HALL TICKET NO: [illegible]

Signature of Student: [illegible]

Course: Basic electrical engineering

Signature of invigilator with date: [illegible]

Q.No. and Marks Awarded

1	2	3	4	5	6	7	8	9	10	11

Signature of the Evaluator: [illegible]

Maximum Marks	[illegible]	Marks Obtained	[illegible]

(Start Writing From Here)

PART - A

1. [C]
2. [C]
3. [A]
4. [D]
5. [C]
6. [D]
7. [C]
8. [C]
9. [A]

PART - II

(16)

Items	Quality	rating	time
Bulbs	3	30	5
tube lights	4	50	8
fridge	1	300	24

formule => $\frac{\text{No. of quality + rating + time}}{1000}$

(i) Bulbs => $\frac{3 \times 30 \times 5}{1000}$

=> 450 / 1000

=> 0.45 kW.h.

(ii) tube lights => $\frac{4 \times 50 \times 8}{1000}$

=> 1600 / 1000

=> 1.6 kW.h.

(iii) fridge => $\frac{1 \times 300 \times 24}{1000}$

=> $\frac{7200}{1000}$

=> 7.2 kW.h.

Total => 0.45 + 1.6 + 7.2

for monthly => 9.25 × 31 (days)

=> 286.75

1 unit => 1 kVA.

for. => 286.75 units

The rate of electricity is '2' rs per unit

So,

=> 286.75 × 2

=> 573.2 rupee.

The electricity bill amount for a month is 573.2 rupee.

(12)

Given Data :-

$V_2 I_2$ = 100 KVA

I_2 = 450

R_2 = 900

x = 1

cos φ = 0.8

formula =>
$$\frac{x\, I_2 R_2 \cos\phi}{x\, I_2 R_2 \cos\phi + W_i + x^2 I_2^2 R_2}$$

$$\Rightarrow \frac{1 \times 100 \times 10^3 \times 0.8}{1 \times 100 \times 10^3 \times 0.8 + (1)^2 + 450 + (450)^2 900}$$

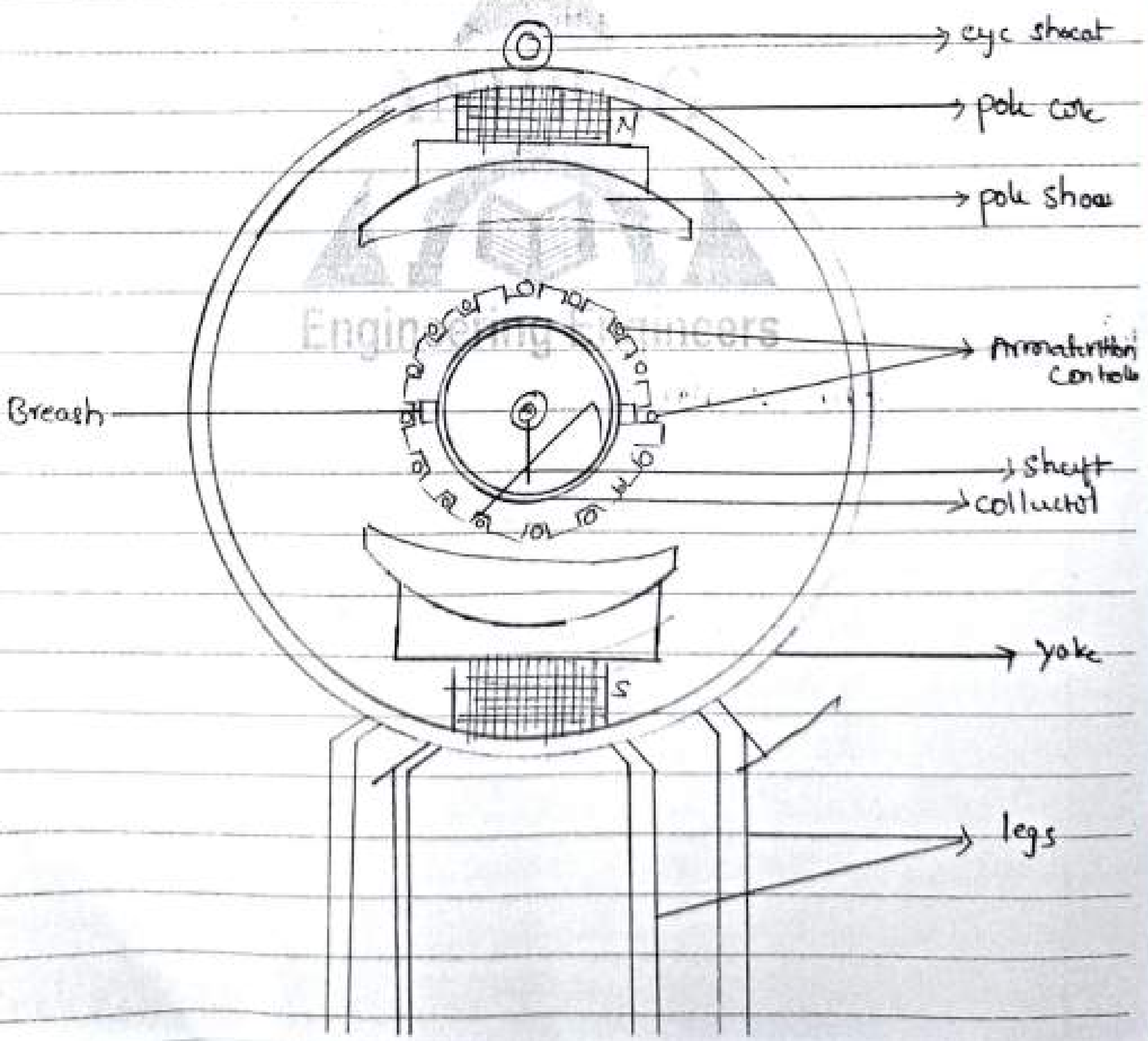
=> $\frac{80000}{182330451}$

=> $4.387637916 \times 10^{-4}$ Wb

The transformer efficiency at full load And the maximum efficiency is $4.387637916 \times 10^{-4}$

5

(13) Induction motor:-



Yoke :- Yoke is a outer protector which protect the DC motor and it was made by loss reduced flux.

pole core :- It is a path where the flux are generated

pole shoe :- In this path where the flux are increases.

Collector :- collector is a path at where AC current is convert to DC current

And it act has a rectifier.

Breach :- Breach is path at where the current collected from collector Breach collect the current from collector. and Breach are made by graphite and carbon.

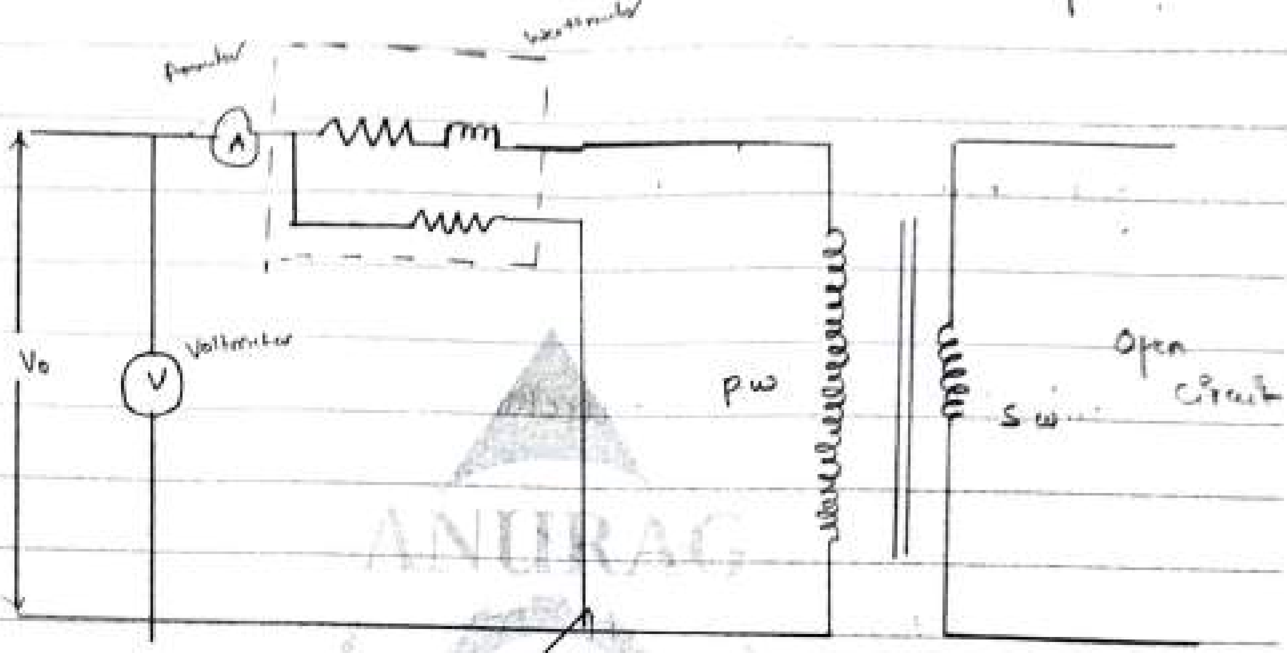
Shaft :- shaft is the rotating path of DC motor.

Legs :- Legs are support to the motor

eye short :- eye shock held all pathes.

5

losses :- losses are two types
i, One is iron losses
and anther one is capper losses
i, iron losses
iron losses held in open circuit



primary winding :- In primary winding the current Supply is connected by voltmeter, Ammeter and wattmeter.

Secondary winding :- In Secondary winding the Secondary winding is open circuit so it's measures the current by Voltmeter, Ammeter and wattmeter. and we find the iron losses here

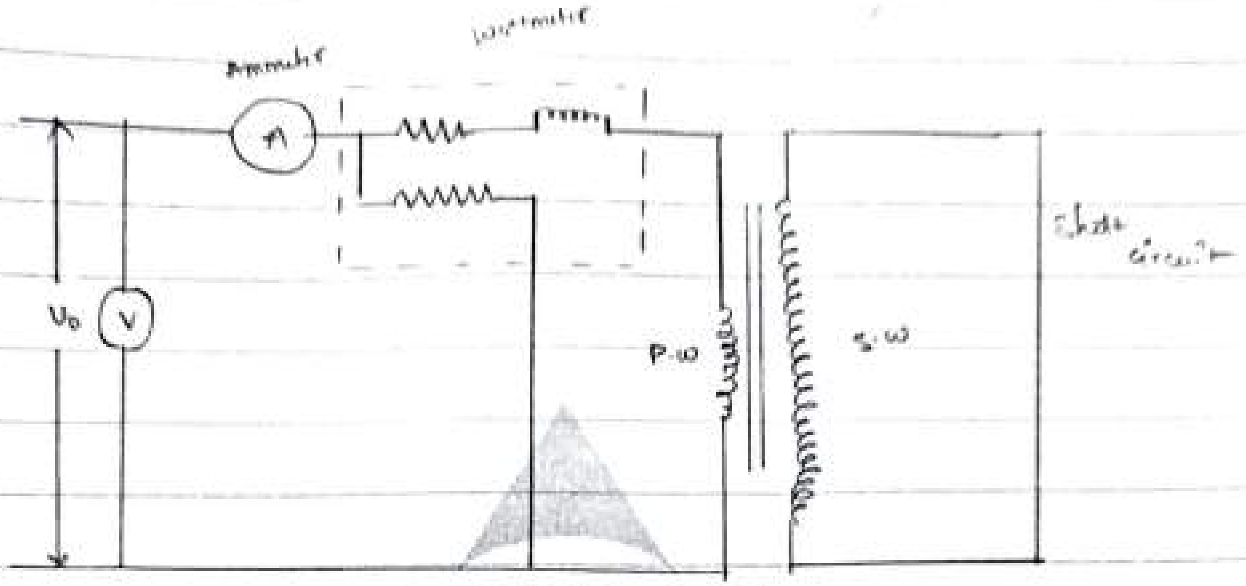
$$w_i = v_2 I_2 \cos\phi$$

$$\cos\phi = \frac{w_i}{v_2 I_2}$$

$w_{cu} = V_1 I_1 \sin\phi$

$R_0 = V_1 / w_i \quad X_0 = I_0 / w_{cu}$

(ii) Copper losses held in short circuit



primary winding :- In primary winding the current supply is connected by voltmeter ~~Ammeter~~ and wattmeter

Secondary winding :- In secondary winding is short circuit By voltmeter, Ammeter and wattmeter and we find the copper losses here.

$\Rightarrow$ ~~$\sqrt{I_0 R_2^2 + X_{02}^2}$~~

Maximum efficiency :-

$$e_g = \frac{\phi Z N}{60} \times P/A$$

for Lap winding $A = P$

for wave winding $A = 1$

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YEAR	SEMESTER	MID EXAMINATION
I	II	II

Regulation : R22 Branch or Specialization: ECE

HALL TICKET NO.

2	2	C	1	1	A	0	4	1	2

Signature of Student: [signature]

Course: BEE

Signature of invigilator with date: N. [signature]

Signature of the Evaluator: [signature]

Q.No. and Marks Awarded

1	2	3	4	5	6	7	8	9	10	11

Maximum Marks: 30

Marks Obtained: 11

(Start Writing From Here)

PART - A

1 B ✗

2 C ✓

3 A ✓

4 D ✓

5 C ✓

6 D ✓

7 B ✓

8 B ✓

9 A ✓

PART-B

11. There are different types of losses in transformer
1. Hysteresis losses
2. Copper losses
3. Core losses
4. Eddy current losses.
Transformer the iron loss is now and full load copper loss. the transformer efficiency at full load and the maximum efficiency of the transformer the load power factor is lagging. Open circuit test on transformers is conducted so as to get the eddy current losses and an ideal transformer will have maximum efficiency at a load such that can not be determined transformer efficiency at full load and the maximum efficiency of the transformer. will have maximum efficiency at the load power factor is 0.8 lagging circuit test on transformer is conducted so as to get the losses in transformer and also the condition for maximum efficiency of the transformer

16 The electricity bill amount for a month of 31 days by the following devices are used as specified

a) 3 bulbs of 30 watts for 5 hours

b) 4 tube lights of 50 watts for 2 hours

c) 1 fridge of 300 watts for 24 hours

the given rate of electricity is 2 Rs per unit.

$$= \frac{\text{No. of appliances} \times \text{rate} \times}{1000}$$

a). $\frac{3 \times 2 \times}{1000}$

b. $\frac{4 \times 2 \times}{1000}$

c. $\frac{1 \times 2 \times}{1000}$

V. Shirisha
23C11A0941
ECE

ANURAG Engineering College

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$\frac{25}{5} = 5$

(Common to IT & ECE)

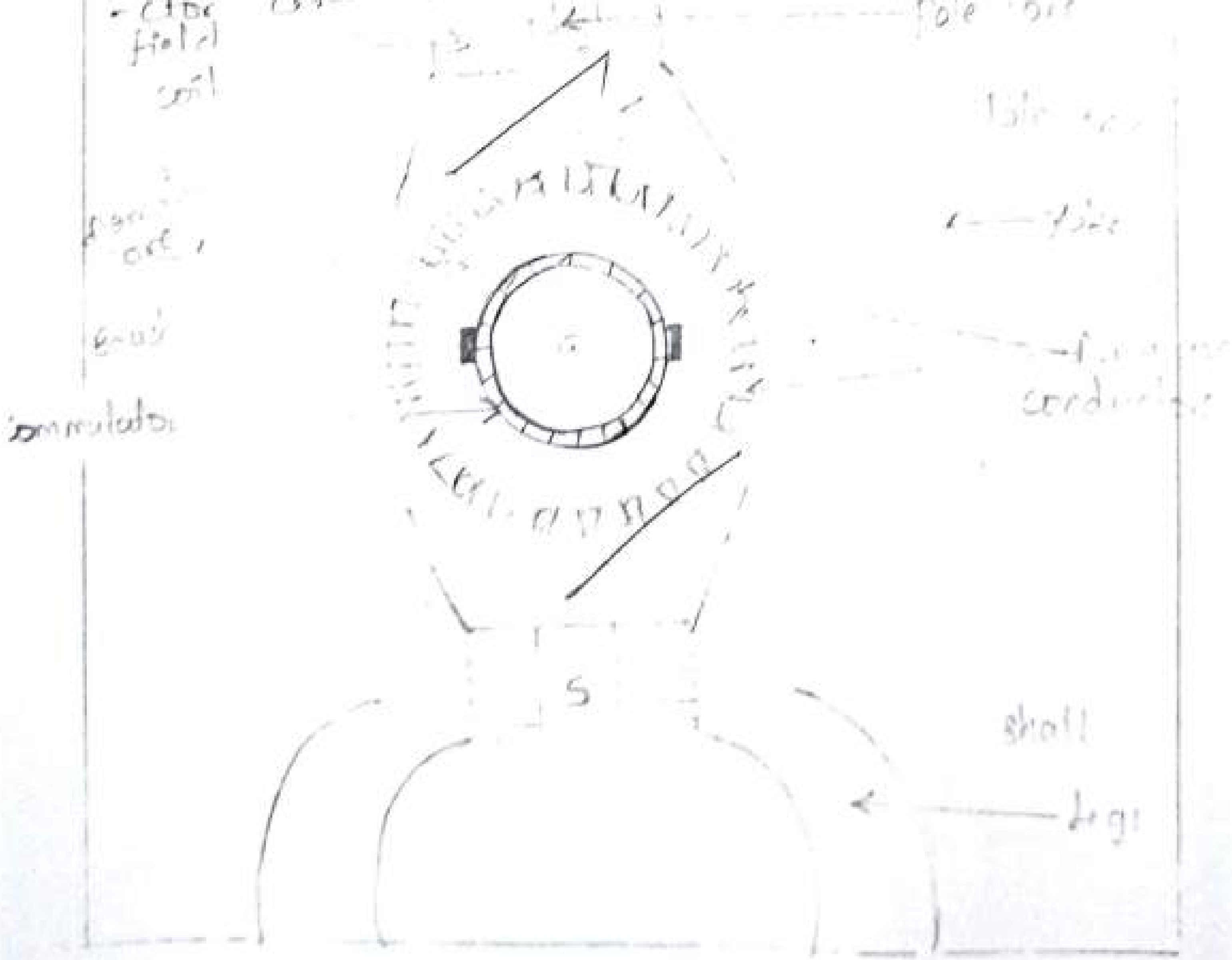
I B.Tech II Semester II Mid Exam Assignment Questions

1. a) Explain the construction details of DC generator?
   b) A single-phase, 25Hz transformer has 50 primary turns and 600 secondary turns. The cross sectional area of the core is 400 sq.cm. If the primary of the Transformer is connected to a 50 HZ supply at 230 V. Find peak flux density and secondary induced voltage.
2. a) Derive an Emf Equation of DC generator.
   b) A 8- pole generator having wave-wound armature winding has 72 slots, each slot containing 40 conductors. What will be the voltage generated in the machine when driven at 1700 rpm assuming the flux per pole to be 5.0 mWb ?
3. Sketch the Torque-slip characteristics of Induction motor and explain.
4. What are the different types of wires and cables? Explain.
5. Calculate the monthly Energy Consumption and Electricity Bill. Assume the electricity rate as 5.00rs per unit.

S. No.	Appliance name	No.	Rating in watts/unit	Operation time
1	Tubelights	3	40	6 hours
2	PL lamp	2	20	1 hour
3	Window type A.C	2	2000	4 hours
4	Domestic exhaust fan	1	100	3 hours
5	Toaster	1	750	15 mins
6	165 litre fridge	1	150	24 hours

1. Construction details of DC generator:-

DC generator converts mechanical energy into electrical energy. when a conductor move in a magnetic field in such a way conductor cuts across a magnetic flux of lines and emf produces in a generator and it is defined by faradays law of electromagnetic induction e.m.f causes current to flow if the conductor circuit is closed.



1] Yoke:-

- Acts as frame of the machine
- Mechanical support
- Low reluctance for magnetic flux and High permeability.
- For small machines - cast iron - low cost
- For large machines - cast steel (Rolled steel)

2] Field magnets:-

a] Pole core (pole body) :- Carry the field coils
- Rectangle across sections
- Laminated to reduce heat losses
- Fitted to yoke through bolts

b] Pole shoe: Acts as support to field poles and spreads out flux.

Pole core & pole shoe are laminated of annealed steel (of thickness of 1mm to 0.25mm)

3] Armature core:-

- To support armature windings
- To rotate conductors in a magnetic field
- It is cylindrical or drum shaped is built
- Made of high permeability silicon steel stampings.

4] Arm...

4] Armature winding:-
Main flux cuts armature and hence E.M.F is induced
- Winding mode of copper (or) Aluminium
- Windings are insulated each other.

5] Commutator:-
- Hard drawn copper bars segments insulated from each other by mica segments (insulator)
- Between armature & External circuit
- Split - Rings (acts like Rectifier Ac to DC)

6) Brushes and brush gear:-
Carbon, carbon graphite, copper used to collects current from commutation (in case of Generator)

7) Shaft and bearings:-
shaft - Mechanical link between prime over and armature
Bearings - For free rotation
- Armature winding is classified into two types of Armature winding:-

i) Lap winding:-
- Used in machines designed for low voltage and high current.
- No. of parallel path, A = P; P = no. of poles

ii) Wave winding:-

- Used in machines designed for high voltage and low current.
- No. of parallel path, A = 2.

∴ The peak flux density is 0.5 wb/m²

And secondary induced voltage is 2760 V.

2. a) EMF Equation of a DC generator :-

Let ϕ = flux/pole in weber

Z = Total number of armature conductors

= No. of slot × No. of conductors/slot

P = No. of generator poles

A = No. of parallel paths in armature

N = Armature rotation in revolution per minute (r.p.m)

E = e.m.f. induced in any parallel path in armature

Generated emf E_g = emf generated in any one of the parallel paths.

i.e. E

Average emf generated/conductor $= \frac{d\phi}{dt}$ volt

Now, flux cut/conductor in one revolution

$d\phi = \phi P$ wb

No. of revolutions/sec = N/60

∴ Time for one revolution, $dt = 60/N$ sec

According to Faraday's law of electromagnetic induction

EMF generated/conductor $= \frac{d\phi}{dt} = \frac{\phi P N}{60}$ volts

No. of conductors (in series) in one parallel path $= \frac{Z}{A}$

∴ E.M.F generated/path $= \frac{\phi P N}{60} \times \frac{Z}{A}$ volts

∴ Generate E.M.F, $E_g = \frac{\phi Z N}{60} \times \frac{P}{A}$ volts

for

i] Wave winding $A = 2$

ii] Lap ~~winding~~ $A = P$

1. b] Given

$P = 8$

slot $= 72$

and each slot containg 40 conductors

⇒ ~~slot/conductors = 40~~

∴ Conductor $(Z) = 72 \times 40 = 2880$

$N = 1700$ rpm

$\phi = 5$ m wb

$A = 2$ (Given wave winding)

2.
b) Given data is

$N_1 = 50$

$N_2 = 600$

$a = 400\,cm^2$

$V_1 = 230\,V$

$f = 50\,Hz$

The emf equation of the transformer

$$E_1 = 4.44\,\phi_m f N_1$$

$$\phi_m = \frac{E_1}{4.44 f N_1}$$

$$\phi_m = \frac{230}{4.44 \times 50 \times 50}$$

$$\phi_m = 0.02\,wb$$

To find peak flux density And secondary voltage :-

$$B_m = \frac{\phi_m}{a} = \frac{0.02}{400 \times 10^{-4}} = 0.5\,wb/m^2$$

$$\frac{V_2}{V_1} = \frac{N_2}{N_1}$$

5

$$V_2 = V_1 \times \frac{N_2}{N_1}$$

$$230 \times \frac{600}{50} \Rightarrow 2760\,V \Rightarrow V_2$$

From, $E_g = \frac{\phi Z N}{60} \times \frac{P}{A}$

$$E_g \Rightarrow \frac{5\times10^{-3}\times2880\times1700\times8}{60\times2}$$

$E_g = 1632$

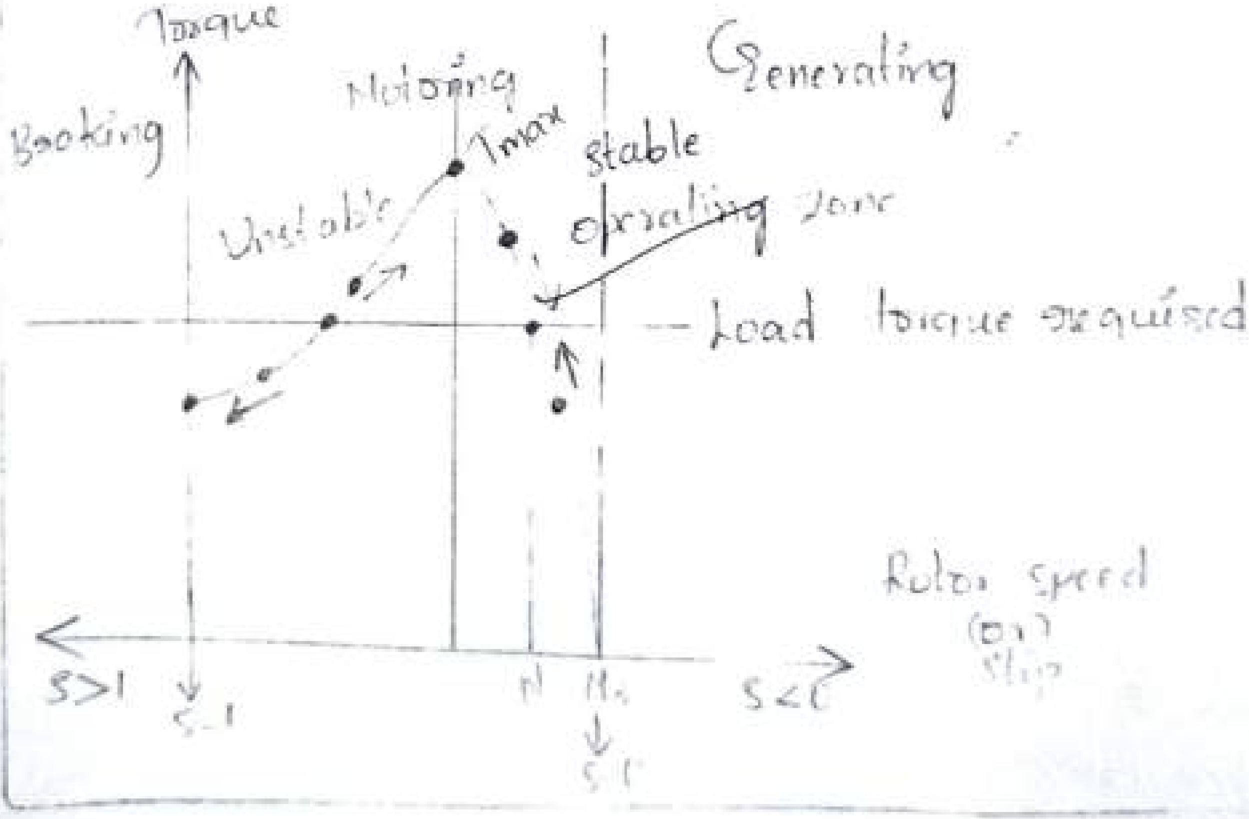
Hence generated voltage $(E_g) = 1632\,V$.

3. a) Torque:-

The turning or twisting force about an axis is Torque

Slip:-

Rotor never catches up with synchronous speed (i.e. the speed of rotating magnetic field). The difference is nothing but the slip.



Applications And Explanation:-

The actual or running speed of an induct -ion motor is influenced by the applied load and the resultant slip. the torque the motor produces is also a function of slip: more slip, more torque. A NEMA Design B motor Generally operates at 3% slip, the motor will produce its rated torque.

The torque slip curve provides essential chara -cteristics of the motor including its capabi -lities, effiency and also operating range. It is used to deesign and analyze motor systems for various applications where high starting torque and high pull-up-torque are required.

5

4. Types of wires and cables:-

The size & type of wire/cable must suit the power rating required for their use. Various types of wires are used for electrical wiring.

- V.I.R (Vulcanized India Rubber) wires:- These types of wires consists of a tinned conductor coated with rubber insulation. The thickness of

rubber wire

rubber varies with the voltage for which the wire is designed i.e., 250 or 660 volts. This rubber insulation is not moisture or heat proof.

- C.T.S (Cable Type sheathed) wires :- In this type ordinary insulated conductors are provided with an additional tough rubber sheath. This also provides a protection against moisture, chemical fumes and tear.

- P.V.C (poly vinyl chloride):- These are the most commonly used wires. These have conductors with P.V.C insulation. P.V.C is non-hydroscopic. Hence is not used where extremes of temperature occur e.g. in heating appliances.

- Cables:- These consists of individually insulated conductors which are put together inside a protective mechanical covering.

- Belted cables:- These cables are used for voltages level up to 11kV.

- Screened Type cables:- These cables are used for the voltage levels of 22 kV. These cables are of two types:

- H - Type cables.
- S.L. Type cables

-H-Typecables:- Designed by M. Hochstetler and hence named H-type cable.

-Super Tension (S.T) cables:- the S.T. cables are intended for 132 kV to 25 kV voltage levels. In such cables, the solid type insulation, low viscosity oils under pressure is used for im-pregnation.

Oil filled cables:- In case of oil filled cables, the oil filled channels or ducts are provided within or adjacent to the cores, through which oil under pressure is circulated.

Gas pressure cables:- An inert gas like N at high pressure is introduced lead shealth and dielectric. Gas like SF_6 is also used in cables. pressure is about 12-15 atmosphere. Working power factors is also high.

ans

Electricity consumed per day in kwh, for each appliances is determined as follows by using the common relation,

$$kwh = \frac{\text{No. of appliances} \times \text{rating} \times \text{operation time}}{1000}$$

i) Energy consumption of tube lights $= \frac{3 \times 40 \times 6}{1000}$

$= 0.72 kwh$

ii) Energy consumption of PL Lamps

$= \frac{2 \times 20 \times 1}{1000} = 0.04 kwh$

iii) Energy consumption of domestic fan

$= \frac{1 \times 100 \times 3}{1000} = 0.3 kwh$

iv) Energy consumption of window A/cs

$= \frac{2 \times 2000 \times 4}{1000} = 16 kwh$

v) Energy consumption of fridge $= \frac{150 \times 1 \times 24}{1000}$

$= 3.6 kwh$

vi) Energy consumption of toaster $= \frac{1 \times 750 \times (15/60)}{1000}$

$= 0.1875 kwh$

monthly Energy consumption.

$\Rightarrow (0.72 + 0.04 + 0.3 + 16 + 0.1875) kwh$

$\Rightarrow 20.84 kwh.$

$\Rightarrow 20.84 \times 30$

⇒ 625.42 kwh

power bill ⇒ 625.42 × 5

⇒ 3127.125 ₹

1 kwh = 1 Unit and electricity rate as

5.00₹ per unit.

5

SYLLABUS

UNIT - I

D.C. Circuits: Electrical circuit elements (R, L and C), voltage and current sources, KVL&KCL, analysis of simple circuits with dc excitation. Superposition, Thevenin's and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

UNIT - II

A.C. Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance in series R-L-C circuit. Three-phase balanced circuits, voltage and current relations in star and delta connections.

UNIT - III

Transformers: Ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. regulation and efficiency. Condition for maximum efficiency and applications.

UNIT - IV

Electrical Machines: Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

UNIT - V

Electrical Installations

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

******

UNIT – I

D.C. CIRCUITS

BASIC DEFINITIONS

1. **Charge:** Charge (q) is an electrical property of the atomic particles of which matter consists, measured in coulombs (C).
2. **Current:** Electric current is the time rate of change of charge, measured in amperes (A). (or) electric current is defined asthe rate of flow of electrons in a conductive or semi conductive material. Expressed mathematically

   $$I = Q/t$$

   Where I is the current, Q is the charge of electrons, and t is the time.
3. **Voltage:** Voltage (or potential difference) is the energy required to move a unit charge through an element, measured in volts (V). The voltage V_{ab} between two points a and b in an electric circuit is the energy (or work) needed to move a unit charge from a to b; mathematically

   $$V_{ab} = d_w/d_q$$

   where w is energy in joules (J) and q is charge in coulombs (C).
4. **Power and Energy:** Energy is the capacity to do work, measured in joules (J). Energy may exist in many forms such as mechanical, electrical, chemical and so on. Power is the rate of change of energy, and is denoted by either P or p.

   $$\text{Power (p)} = \text{Energy/time} = W/t \text{ (or) } p = d_w/d_t$$

   Where d_w is the change in time and dt is the change in time. We can also write

$$p = d_w/d_t = (d_w/d_q) * (d_q/d_t) = v * i \text{ watts.}$$

5. **Network and Circuit:** An electrical network is an interconnection of electrical components (e.g. voltage sources, current sources, resistances, inductances, capacitances). An electrical circuit is a network consisting of a closed loop, giving a return path for the current.
6. **Ohm's law:** Ohm's law states that at constant temperature, the voltage V across a resistor is directly proportional to the current i flowing through the resistor. That is

$$v \infty i$$

$$v = i R$$

<u>ELECTRICAL CIRCUIT ELEMENTS (R, L AND C)</u>

Resistor

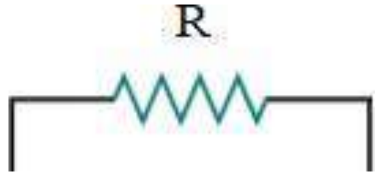
A resistor is a passive two terminal electrical element that is used to limit (or) regulate the flow of electric current.

Resistance

The resistance R of an element denotes its ability to resist the flow of electric current. It is measured in ohms (Ω).

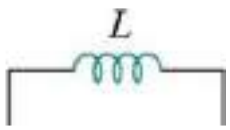
$$R = v/i$$

Power observed by the resistor is $p = v * i = i^2R = v^2/R$



Inductor

An inductor is a passive element designed to store energy in its magnetic field. An inductor consists of a coil of conducting wire. If current is made to pass through an inductor, an electromagnetic field is formed. A change in current, produces change in the electromagnetic field, which induces a voltage across the coil according to faraday's law of electromagnetic induction.



$$v = L\frac{di}{dt}$$

Where V = voltage across inductor in volts

i = current flowing through inductor in amps

Inductance

It is the property of a material, by which it opposes any sudden change of current passing through it, measured in henry (H).

Power observed by inductor is

$$p = v * i = L\ (di/dt) * i$$

Energy stored by the inductor is $W = (1/2)\ L\ i^2$

Note: The induced voltage across an inductor is zero, if the current through it is constant i.e. inductor acts as short circuit to DC.

Capacitor

A capacitor is a passive element designed to store energy in its electric field. Capacitors are used extensively in electronics, communications, computers, and power systems.

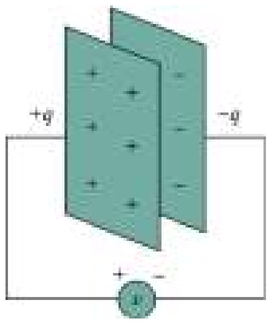
A capacitor consists of two conducting plates separated by an insulator (or dielectric).

When a voltage source v is connected to the capacitor, as in Fig., the source deposits a positive charge +q on one plate and a negative charge −q on the other. The capacitor is said to store the electric charge. The amount of charge stored, represented by q, is directly proportional to the applied voltage v so that

$$q = C * v$$

$$=> C = q/v$$

Where C, the constant of proportionality, is known as the capacitance of the capacitor.



Although the capacitance C of a capacitor is the ratio of the charge q per plate to the applied voltage v, it does not depend on q or v. It depends on the physical dimensions of the capacitor.

$$C = \frac{\epsilon A}{d}$$

Where A is the surface area of each plate, d is the distance between the plates, and € is the permittivity of the dielectric material between the plates.

Capacitance

It is a measure of the amount of electric charge stored for a given electric potential and is given by the ratio of the charge on oneplate of a capacitor to the voltage difference between the two plates, measured in farads (F).

$$\text{w.r.t } i = dq/dt = d(Cv)/dt = C\, dv/dt.$$

Where v = voltage across the capacitor, i = current through the capacitor.

Power observed by capacitor is

$$p = v * i = v\, C\, (dv/dt)$$

Energy stored by the capacitor is $W = (1/2)\, C\, v^2$

Note: The current in a capacitor is zero, if the voltage across it is constant, i.e. capacitor acts as an open circuit to DC.

KIRCHHOFF'S LAWS: KVL & KCL

Kirchhoff's Current Law (KCL)

Kirchhoff's first law is based on the law of conservation of charge, which requires that the algebraic sum of charges within a system cannot change.

Kirchhoff's current law (KCL) states that the algebraic sum of currents entering anode is zero.

Mathematically, KCL implies that

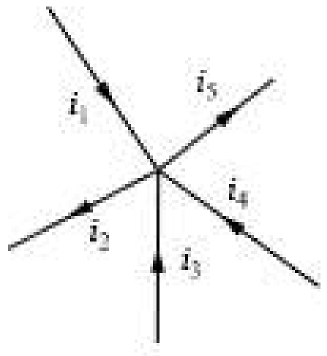
$$\sum_{n=1}^{N} i_n = 0$$

Where N is the number of branches

Connected to the node and in is the nth current entering (or leaving) the node.

Consider the node in Fig.a. Applying KCL gives

$i_1 + (-i_2) + i_3 + i_4 + (-i_5) = 0$



Since currents i_1, i_3, and i_4 are entering the node,

While currents i_2 and i_5 are leaving it.

By rearranging the terms, we get

$$i_1 + i_3 + i_4 + = i_2 + i_5$$

The sum of the currents entering a node is equal to the sum of the currents leaving the node.

Kirchhoff's Voltage Law (KVL)

Kirchhoff's second law is based on the principle of conservation of energy:

Kirchhoff's voltage law (KVL) states that the algebraic sum of all voltages around a closed path (or loop) is zero.

Expressed mathematically, KVL states that

$$\sum_{m=1}^{M} v_m = 0$$

Where M is the number of voltages in the loop (or the number of branches in the loop) and Vm is the mth voltage.

Consider the circuit in Fig.b, the sign on each voltage is the polarity of the terminal encountered first as we travel around the loop. We can start with any branch and go around the loop either clockwise or counter clockwise. Suppose we start with the voltage source and go clockwise around the loop as shown, then voltages would be $+V_1$, $-V_2$, $-V_3$, $+V_4$, and$-V_5$, in that order.

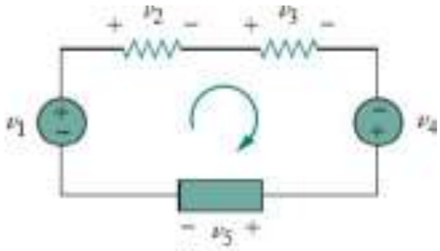


Fig.b

$$V_1 - V_2 - V_3 + V_4 - V_5 = 0$$

Rearranging terms gives, $V_1 + V_4 = V_2 + V_3 + V_5$

Which may be interpreted as

The sum of the voltage drops around a loop = the sum of the voltage rises around the loop

Mesh Analysis:

Mesh analysis provides general procedure for analyzing circuits using mesh currents as the circuit variables. Mesh Analysis is applicable only for planar networks. It is preferably useful for the circuits that have many loops .This analysis is done by using KVL and Ohm's law.

In Mesh analysis, we will consider the currents flowing through each mesh. Hence, Mesh analysis is also called as Mesh-current method.

A branch is a path that joins two nodes and it contains a circuit element. If a branch belongs to only one mesh, then the branch current will be equal to mesh current.

If a branch is common to two meshes, then the branch current will be equal to the sum (or difference) of two mesh currents, when they are in same (or opposite) direction.

Procedure of Mesh Analysis

Follow these steps while solving any electrical network or circuit using Mesh analysis.

- **Step 1 –** Identify the meshes and label the mesh currents in either clockwise or anti-clockwise direction.
- **Step 2 –** Observe the amount of current that flows through each element in terms of mesh currents.
- **Step 3 –** Write mesh equations to all meshes. Mesh equation is obtained by applying KVL first and then Ohm's law.
- **Step 4 –** Solve the mesh equations obtained in Step 3 in order to get the mesh currents.

Now, we can find the current flowing through any element and the voltage across any element that is present in the given network by using mesh currents.

NETWORK THEOREMS

1. Superposition Theorem.
2. Thevenin's Theorem.
3. Norton's Theorem.

1. Superposition Theorem

In a network of linear resistances containing more than one generator (or source of of all the currents which would flow at that point if each generator were considered separately and all the other generators replaced for the time being by resistances equal to their internal resistance emf), the current which flows at any point isthe sum resistance.

Steps to Apply Super position Principle:

1. Replace all independent sources with their internal resistances except one source. Find the output (voltage or current) due to that active source using nodal or mesh analysis.

2. Repeat step 1 for each of the other independent sources.

3. Find the total contribution by adding algebraically all the contributions due to the independent sources.

2. Thevenin Theorem

Any pair of terminals AB of a linear active network may be replaced by an equivalent voltage source in series with an equivalent resistance Rth. The value of Vth (called the Thevenin's voltage) is equal to potential difference between the terminals AB when they are open circuited, and Rth is the equivalent resistance looking into the network at AB with the independent active sources set to zero i.e with all the independent voltage sources short-circuited and all the independent current sources open circuited.

Main steps to find out VTh and RTh :

1. The terminals of the branch/element through which the current is to be found out are marked as say a & b after removing the concerned branch/element
2. Open circuit voltage VOC across these two terminals is found out using the conventional network mesh/node analysis methods and this would be VTh .
3. Thevenin's resistance RTh is found out by the method depending upon whether the network contains dependent sources or not.
   a. With dependent sources: RTh = Voc / Isc
   b. Without dependent sources : RTh = Equivalent resistance looking into the concerned terminals with all voltage & current sources replaced by their internal impedances (i.e. ideal voltage sources short circuited and ideal current sources open circuited)
4. Replace the network with VTh in series with RTh and the concerned branch resistance (or) load resistance across the load terminals (A&B) as shown in below fig.

3. Norton Theorem

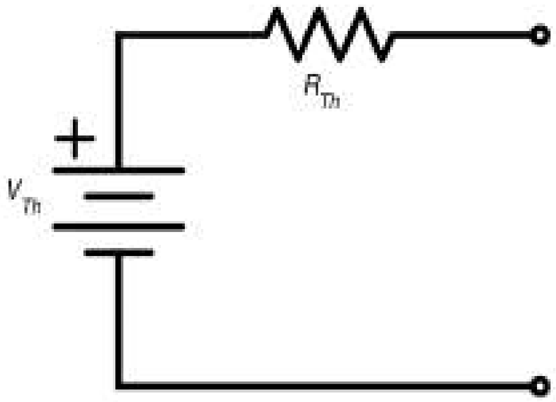
Any two terminal linear active network (containing independent voltage and current sources), may be replaced by a constant current source IN in parallel with a resistance RN, where IN is the current flowing through a short circuit placed across the terminals and RN is the equivalent resistance of the network as seen from the two terminals with all sources replaced by their internal resistance.

Main steps to find out I_N and R_N:

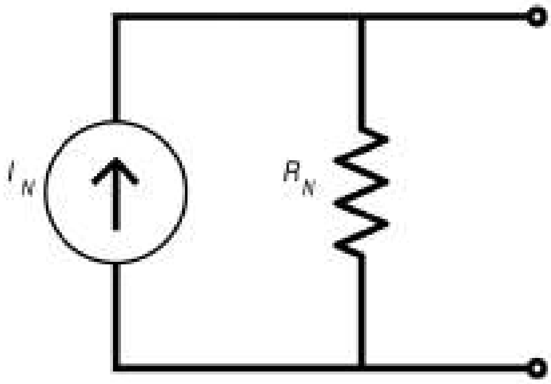
- The terminals of the branch/element through which the current is to be found out are marked as say **a & b** after removing the concerned branch/element.
- Open circuit voltage $\mathbf{V_{OC}}$ across these two terminals and $\mathbf{I_{SC}}$ through these two terminals are found out using the conventional network mesh/node analysis methods and they are same as what we obtained in Thevenin's equivalent circuit**.**
- Next **Norton resistance R_N** is found out depending upon whether the network contains dependent sources or not.
    a) With dependent sources: $\mathbf{R_N = V_{oc} / I_{sc}}$
    b) Without dependent sources : $\mathbf{R_N}$ **=** Equivalent resistance looking into the concerned terminals with all voltage & current sources replaced by their internal impedances (i.e. ideal voltage sources short circuited and ideal current sources open circuited)

Replace the network with $\mathbf{I_N}$ in parallel with $\mathbf{R_N}$ and the concerned branch resistance across the load terminals(A&B)

Thevenin



Norton



UNIT - II

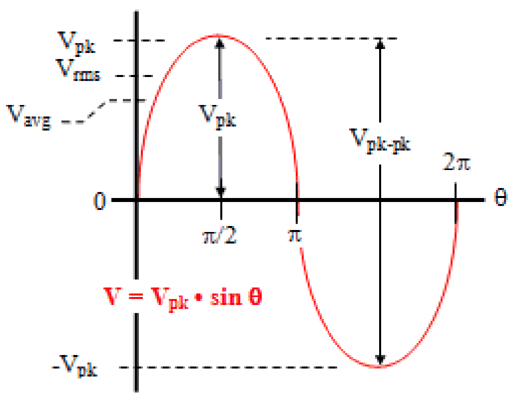
A.C. CIRCUITS

REPRESENTATION OF SINUSOIDAL WAVEFORMS

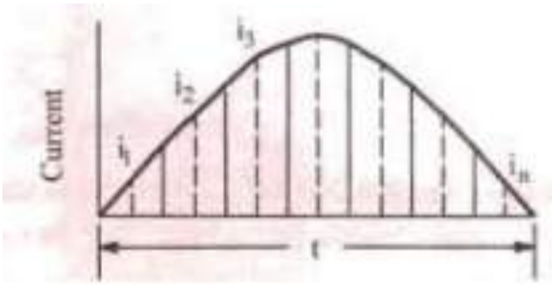
A sinewave is defined by the trigonometric sine function. When plotted as voltage (V) as a function of phase (θ), it looks similar to the figure to the below. The waveform repeats every 2p radians (360°), and is symmetrical about the voltage axis (when no DC offset is present). Voltage and current exhibiting cyclic behavior is referred to as alternating; i.e., alternating current (AC). One full cycle is shown here. The basic equation for a sinewave is as follows:

$$V(\theta) = V_{pk} \cdot \sin(\theta)$$

There are a number of ways in which the amplitude of a sinewave is referenced, usually as peak voltage (V_{pk} or V_p), peak-to-peak voltage (V_{pp} or V_{p-p} or V_{pkpk} or V_{pk-pk}), average voltage (V_{av} or V_{avg}), and root-mean-square voltage (V_{rms}). Peak voltage and peak-to peak voltage are apparent by looking at the above plot. Root mean-square and average voltage are not so apparent.



ROOT MEAN SQUARE (RMS) OR EFFECTIVE OR VIRTUAL VALUE OF A.C

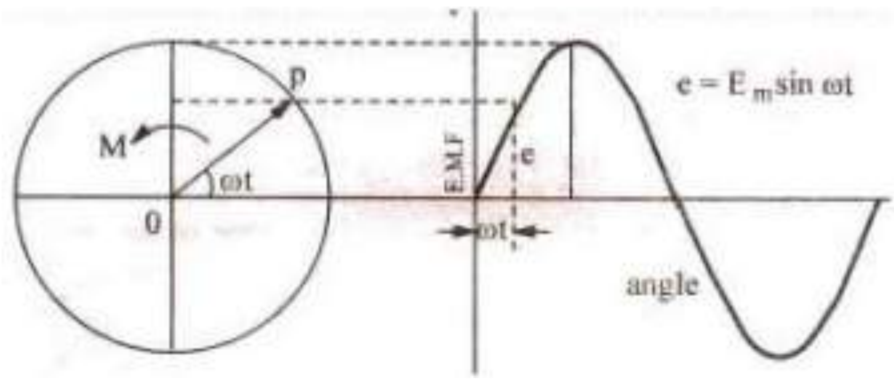


$$I_{rms} = \sqrt{\frac{i_1^2 + i_2^2 + \ldots\ldots + i_n^2}{n}} = \text{Square root of the mean of square of the instantaneous currents}$$

- It is the square root of the average values of square of the alternating quantity over a time period.

$$I_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2(\omega t)\,d(\omega t)}$$

PHASOR & PHASOR DIAGRAM

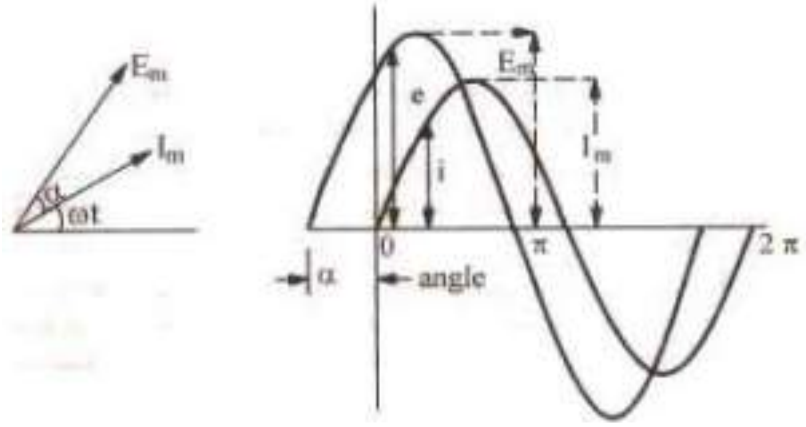


Phasor

Alternating quantities are vector (i.e having both magnitude and direction). Their instantaneous values are continuously changing so that they are represented by a rotating vector (or phasor). A phasor is a vector rotating at a constant angular velocity.

Phasor diagram

Phasor diagram is one in which different alternating quantities of the same frequency are represented by phasors with their correct phase relationship.



Points to remember

1. The angle between two phasors is the phase difference.
2. Reference phasor is drawn horizontally.
3. Phasors are drawn to represent rms values.
4. Phasors are assumed to rotate in anticlockwise direction.
5. Phasor diagram represents a "still position" of the phasors in one particular Point.

POWER FACTOR

The phase angle of the load impedance plays a very important role in the absorption of power by load impedance. The average power dissipated by an AC load is dependent on the cosine of the angle of the impedance. To recognize the importance of this factor in AC power computations, the term cos (θ) is referred to as the power factor (pf). Note that the power factor is equal to 0 for a purely inductive or capacitive load and equal to 1 for a purely resistive load; in every other case, 0<pf<1. If the load has an inductive reactance, then θ is positive and the current lags (or follows) the voltage. Thus, when θ and Q are positive, the corresponding power factor is termed lagging. Conversely, a capacitive load will have a negative Q, and hence a negative θ. This corresponds to a leading power factor, meaning that the load current leads the load voltage.

A power factor close to unity signifies an efficient transfer of energy from the AC source to the load, while a small power factor corresponds to inefficient use of energy. Two equivalent expressions for the power factor are given in the following:

$$\text{pf} = \cos(\theta) = \frac{P_{av}}{\tilde{V}\tilde{I}} \qquad \text{Power factor}$$

where $\tilde{V}$ and $\tilde{I}$ are the rms values of the load voltage and current.

ACTIVE, REACTIVE AND APPARENT POWER

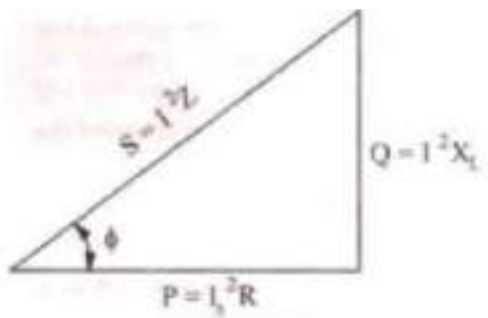


Fig. Power Triangle

$S^2 = P^2 + Q^2$

$S = P + jQ$

Apparent power (S)

It is the product of rms values of the applied voltage and circuit current. It is also known as wattless (idle) component.

$$S = VI = IZ \times I = I^2Z \text{ volt-amp}$$

Active power or true power (P)

It is the power which actually dissipated in the circuit resistance. It is also known as wattful component of power.

$$P = I^2R = I^2Z\cos\Phi = VI\cos\Phi \text{ watt}$$

Reactive power (Q)

It is the power developed in the reactance of the circuit.

$$Q = I^2X = I^2Z\sin\Phi = VI\sin\Phi \text{ VAR}$$

<u>RESONANCE IN SERIES R-L-C CIRCUIT</u>

Resonance

An AC circuit is said to be in resonance when the circuit current is in phase with the applied voltage. So, the power factor of the circuit becomes unity at resonance and the impedance of the circuit consists of only resistance.

Series Resonance

In R-L-C series circuit, both XL and XC are frequency dependent. If we vary the supply frequency then the values of XL and XC varies. At a certain frequency called resonant frequency (fr), XL becomes equal to XC and series resonance occurs.

At series resonance, $X_L = X_C$

$2\pi f_r L = 1/2\pi f_r C$

$f_r = 1/2\pi\sqrt{LC}$

Impedance of RLC series circuit is given by:

$$Z=\sqrt{R^2+(X_L-X_C)^2} \quad (\text{Since}, X_L = X_C)$$

$$Z=\sqrt{R^2}$$

$$Z=R$$

$$\cos\varphi=\frac{R}{Z}=\frac{R}{R}=1$$

Properties of series resonance

1. The circuit impedance Z is minimum and equal to the circuit resistance R.
2. The circuit current I = V/Z = V/R and the current is maximum.
3. The power dissipated is maximum, $P = V^2/R$
4. Resonant frequency is fr = 1/2pÖLC
5. Voltage across inductor is equal and opposite to the voltage across capacitor.
6. Since power factor is 1, so zero phase difference. Circuit behaves as a purely resistive circuit.

Note: Refer Class Notes for Answers

1. Derive the Impedance of series RL Circuit and draw the impedance diagram.
2. Derive the Impedance of series RC Circuit and draw the impedance diagram.
3. Derive the Impedance of series RLC Circuit and draw the impedance diagram.
4. Problems

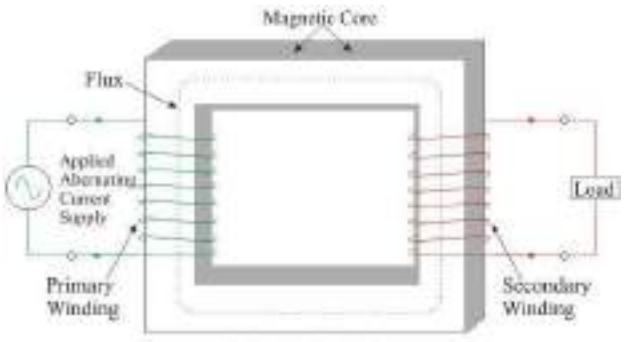
UNIT - III

TRANSFORMERS

What is a transformer?

A transformer is a static device that transfers electrical power from one circuit to another circuit without changing frequency. Alternating voltages can be raised or lowered as per requirements in the different stages of electrical network as generation, transmission, distribution and utilization. This is possible with a static device called transformer.

Working principle of transformer:-



Single Phase Transformer

1)The basic working principle of a transformer is mutual induction between two windings linked by common magnetic flux
2)The primary and secondary coils are electrically separated but magnetically linked to each other
3)When primary winding is connected to a source of alternating voltage, alternating magnetic flux is produced around the winding.
4)If the secondary winding is closed circuit, then mutually induced makes the current flow through it, and hence the electrical energy is transferred from one circuit (primary) to another circuit (secondary).

IDEAL TRANSFORMER

An imaginary transformer which has the following properties

1. Primary and secondary winding resistance are negligible, hence no resistive voltage drop.
2. Leakage flux and leakage inductance are zero. There is no reactive voltage drop in the windings.
3. Power transformer efficiency is 100% i.e. there are no hysteresis loss, eddy current loss or heat loss due to resistance.
4. Permeability of the core is infinite so that it requires zero emf to create flux in the core.

Power In the primary = power in the secondary.

$$E_1I_1= E_2I_2$$

$$I_1/I_2 = E_2/E_1 = N_2/N_1 = K = V_2/V_1$$

1. When transferring resistance or reactance from primary to secondary, multiply it by K^2
2. When transferring resistance or reactance from secondary to primary, divide it by K^2
3. Transferring voltage or current, only K is used.
   i. Any voltage V in primary becomes KV in secondary.
   ii. Any voltage V in secondary becomes V/Kin primary.
   iii. Any current I in primary becomes I/K in secondary.
   iv. Any current I in secondary becomes KI in primary.
   v. A resistance R in primary K^2R in secondary.
   vi. A resistance R in secondary becomes R/K^2.

PRACTICAL TRANSFORMER

Practical Transformer on no load

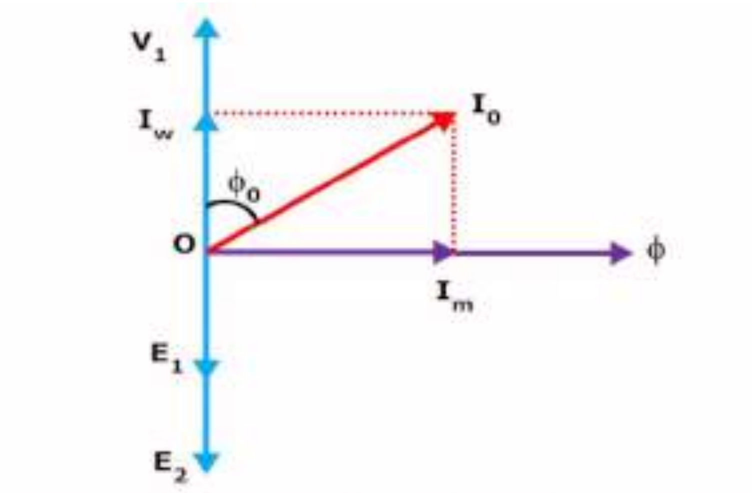


Figure 4: Phasor diagram of practical transformer on no load

A transformer is said to be on no load if its primary winding is connected to AC supply and secondary is open. i.e secondary current is zero. When an A.C voltage is applied to primary, a small current I_0 flows in primary.

I_0 = No-load current

I_m = magnetizing current. It magnetizes the core and sets flux. So, in phase with it.

I_m is called the reactive or wattless component of no load current

I_w produces eddy current and hysteresis losses in the core and very small copper loss in primary. It is called active or wattful component of no load current.

I_w is in phase with the applied voltage (V_1) at the primary.

No load current I0 is small. So drops in R_1 and X_1 on primary side are very small. At no load $V_1 = E_1$.

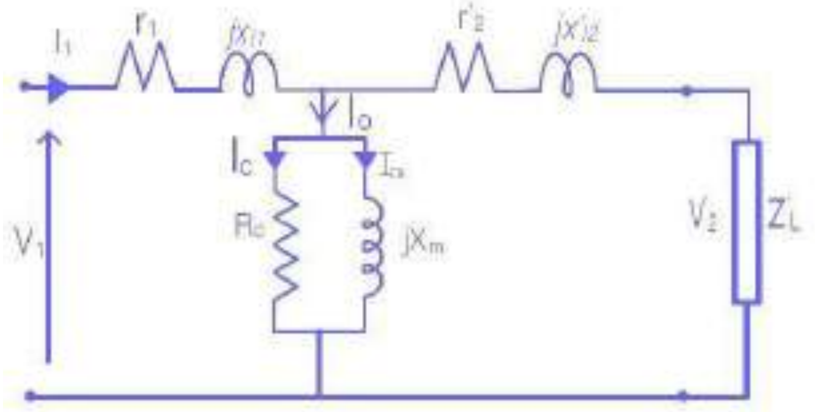
No load primary copper loss ($I_0^2R_1$) is very small. So, no load primary input power is equal to iron loss

$$I_w = I_0 \cos\varphi_0 \, , \, I_m = I_0 \sin\varphi_0 \, , \, I_0 = \sqrt{I_m^{\,2} + I_w^{\,2}}$$

$$\text{No load power factor}, \cos\varphi_0 = \frac{I_w}{I_0}$$

$$\text{No load input power (active power)} = V_1 I_0 \cos\varphi_0 \, ,$$

$$\text{No load reactive power} = V_1 I_0 \sin\varphi_0$$



(a)

EQUIVALENT CIRCUIT

The equivalent circuit of the transformer referred to primary is shown in the below figure in which the winding parameters of the secondary are transformed and was referred to primary based on the voltage balancing principle before and after the transformation.

Secondary Resistance referred to primary:

$$R_2^1 = \frac{V_1}{I_1} = \frac{V_1}{I_1} \times \frac{V_2 I_2}{V_2 I_2} = \times \frac{V_1 I_2}{V_2 I_1} \times \frac{V_2}{I_2} = \frac{R_2}{K^2} \qquad \left(\because \frac{V_1}{V_2} = \frac{I_2}{I_1} = \frac{1}{K} \right) also \frac{V_2}{I_2} = R_2$$

$\therefore R_2^1 = \frac{R_2}{K^2}$ Thus, it is the secondary resistance referred to primary

Secondary Reactance referred to primary:

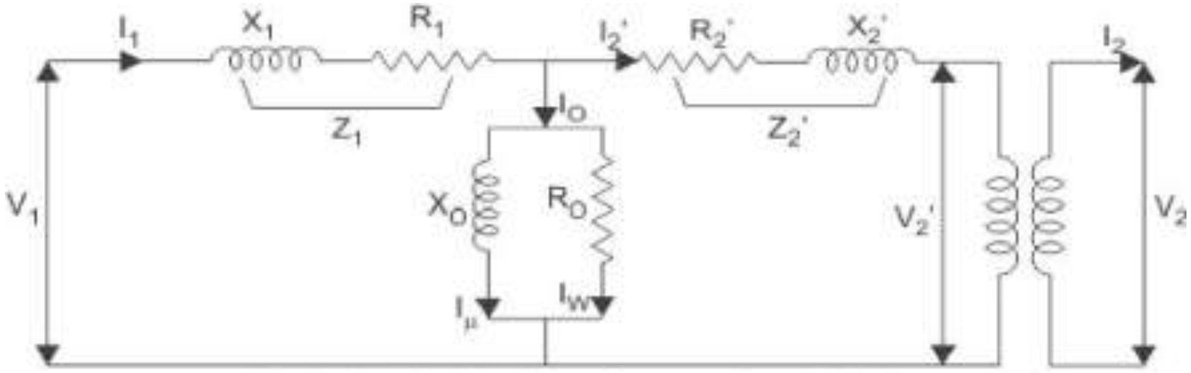
$$X_2^1 = \frac{V_1}{I_1} = \frac{V_1}{I_1} \times \frac{V_2 I_2}{V_2 I_2} = \times \frac{V_1 I_2}{V_2 I_1} \times \frac{V_2}{I_2} = \frac{X_2}{K^2} \qquad \left(\because \frac{V_1}{V_2} = \frac{I_2}{I_1} = \frac{1}{K} \right) also \frac{V_2}{I_2} = X_2$$

$\therefore X_2^1 = \frac{X_2}{K^2}$ Thus, it is the secondary reactance referred to primary

Secondary Impedance referred to primary:

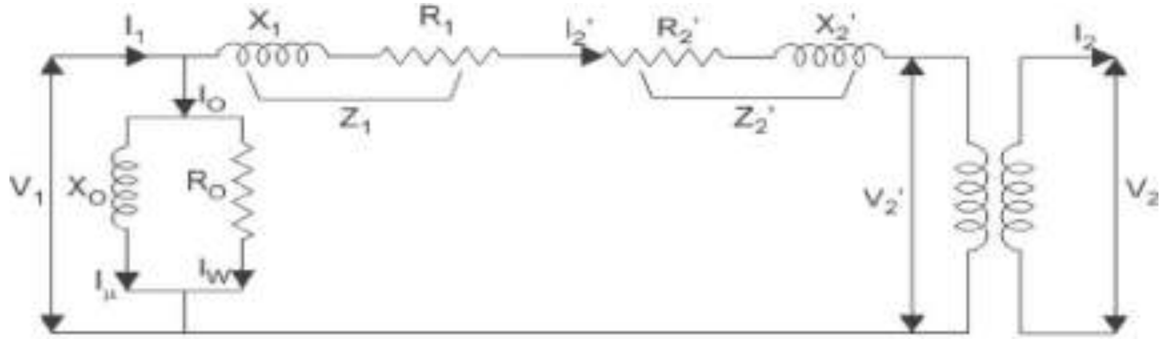
$$Z_2^1 = \frac{V_1}{I_1} = \frac{V_1}{I_1} \times \frac{V_2 I_2}{V_2 I_2} = \times \frac{V_1 I_2}{V_2 I_1} \times \frac{V_2}{I_2} = \frac{Z_2}{K^2} \qquad \left(\because \frac{V_1}{V_2} = \frac{I_2}{I_1} = \frac{1}{K} \right) also \frac{V_2}{I_2} = Z_2$$

$\therefore Z_2^1 = \frac{Z_2}{K^2}$ Thus, it is the secondary impedance referred to primary



Equivalent Circuit of Transformer referred to Primary

To have simplified calculations the equivalent circuit is modified as bringing the core branch towards the supply voltage instead of having in between the primary and secondary parameters.



simplified equivalent circuit of transformer reffered to primary

In this simplified circuit the total resistance, reactance and impedances referred to primary are

$$\therefore R_{eq1} = R_1 + R_2^1 = R_1 + \frac{R_2}{K^2} \qquad \therefore X_{eq1} = X_1 + X_2^1 = X_1 + \frac{X_2}{K^2}$$

$$\therefore Z_{eq1} = Z_1 + Z_2^1 = Z_1 + \frac{Z_2}{K^2}$$

Similarly, the equivalent circuit referred to secondary of the transformer is shown below with their formulas

Primary Resistance referred to secondary:

$$R_1^1 = \frac{V_2}{I_2} = \frac{V_2}{I_2} \times \frac{V_1 I_1}{V_1 I_1} = \times \frac{V_2 I_1}{V_1 I_2} \times \frac{V_1}{I_1} = K^2 R_1 \qquad \left(\because \frac{V_2}{V_1} = \frac{I_1}{I_2} = K\right) also \frac{V_1}{I_1} = R_1$$

$\therefore R_1^1 = R_1 K^2$ Thus, it is the primary resistance referred to secondary

Primary Reactance referred to secondary:

$$X_1^1 = \frac{V_2}{I_2} = \frac{V_2}{I_2} \times \frac{V_1 I_1}{V_1 I_1} = \times \frac{V_2 I_1}{V_1 I_2} \times \frac{V_1}{I_1} = K^2 X_1 \qquad \left(\because \frac{V_2}{V_1} = \frac{I_1}{I_2} = K\right) also \frac{V_1}{I_1} = X_1$$

$\therefore X_1^1 = X_1 K^2$ Thus, it is the primary reactance referred to secondary

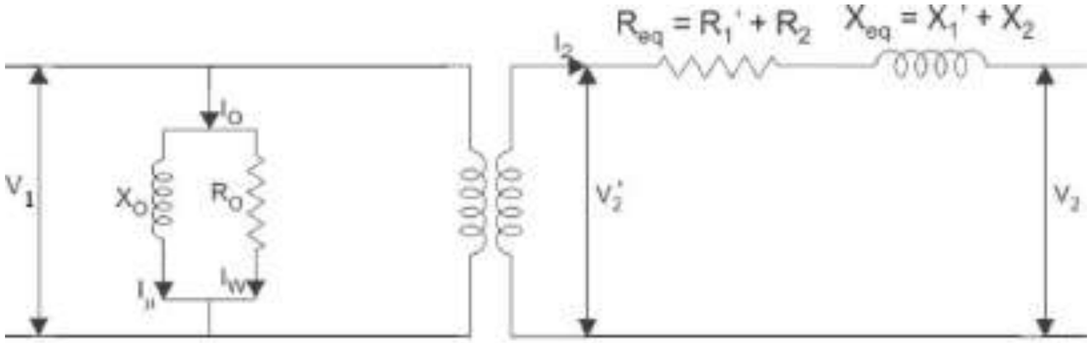
Primary Impedance referred to secondary:

$$Z_1^1 = \frac{V_2}{I_2} = \frac{V_2}{I_2} \times \frac{V_1 I_1}{V_1 I_1} = \times \frac{V_2 I_1}{V_1 I_2} \times \frac{V_1}{I_1} = K^2 Z_1 \qquad \left(\because \frac{V_2}{V_1} = \frac{I_1}{I_2} = K\right) also \frac{V_1}{I_1} = Z_1$$

$\therefore Z_1^1 = Z_1 K^2$ Thus, it is the primary impedance referred to secondary

$\therefore R_{eq2} = R_2 + R_1^1 = R_2 + R_1 K^2 \qquad \therefore X_{eq2} = X_2 + X_1^1 = X_2 + X_1 K^2$

$\therefore Z_{eq2} = Z_2 + Z_1^1 = Z_2 + Z_1 K^2$



Approximate Equivalent Circuit of Transformer referred to Secondary

LOSSES IN TRANSFORMERS

Transformer is a static device, i.e. it doesn't have any parts, so no mechanical losses exist in the transformer and only electrical losses are observed. So there are two primary types of losses in the transformer:

1. Copper losses.
2. Iron/Core losses.
   i. Eddy Current losses.
   ii. Hysteresis Loss.

Other than these, some small amount of power losses in the form of 'stray losses' are also observed, which are produced due to the leakage of magnetic flux.

1. Copper losses

These losses occur in the windings of the transformer when heat is dissipated due to the current passing through the windings and the internal resistance offered by the windings. So these are also known as ohmic losses or I^2R losses, where 'I' is the current passing through the windings and R is the internal resistance ofthe windings.

These losses are present both in the primary and secondary windings of the transformer and depend upon the load attached across the secondary windings since the current varies with thevariation in the load, so these are variable losses.

2. Iron losses or Core Losses

These losses occur in the core of the transformer and are generated due to the variations in the flux. These losses depend upon the magnetic properties of the materials which are present in the core, so they are also known as iron losses, as the core of the Transformer is made up of iron. And since they do not change like the load, so these losses are also constant losses. There are two types of Iron losses in the transformer:

i. Eddy Current losses.
ii. Hysteresis Loss.

i. Eddy Current Losses

When an alternating current is supplied to the primary windings of the transformer, it generates an alternating magnetic flux in the winding which is then induced in the secondary winding also through Faraday's law of electromagnetic induction, and is then transferred to the externally connected load.

During this process, the other conduction materials of which the core is composed of; also gets linked with this flux and an emf is induced. But this magnetic flux does not contribute anything towards the externally connected load or the output power and is dissipated in the form of heat energy.

So such losses are called Eddy Current losses and are mathematically expressed as:

$$P_e = K_e\, f^2\, Kf^2\, B_m^{\ 2}$$

Where;

K_e = Constant of Eddy Current

K_f^2 = Form Constant

B_m = Strength of Magnetic Field

ii. Hysteresis Loss

Hysteresis loss is defined as the electrical energy which is required to realign the domains of the ferromagnetic material which is present in the core of the transformer. These domains loose their alignment when an alternating current is supplied to the primary windings of the transformer and the emf is induced in the ferromagnetic material of the core which disturbs the alignment of the domains and afterwards they do not realign properly.

For their proper realignment, some external energy supply, usually in the form of current is required. This extra energy is known as Hysteresis loss. Mathematically, they can be defined as;

$$P_h = K_h B_m^{1.6} f V$$

OC and SC tests on a single phase transformer

- Purpose of conducting OC and SC tests is

  to find

i) Equivalent circuit parameters ii) Efficiency iii) Regulation

Open Circuit Test:

1. The OC test is performed on LV side at rated voltage and HV side is kept opened.
2. As the test is conducted on LV side the meters selected will be at low range values like smaller voltmeter, smaller ammeter and low pf wattmeter
3. As the no-load current is quite small about 2 to 5% of the rated current, the ammeter required here will be smaller range even after on LV side which are designed for higher current values.
4. The voltmeter, ammeter and the wattmeter readings V0, I0 and W0

   respectively are noted by applying rated voltage on LV side.
5. The wattmeter will record the core loss because of noload input power.

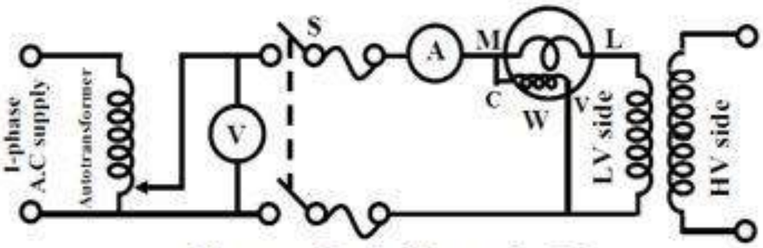


Figure : Circuit diagram for O.C test

Calculations from OC test readings:

R_0, X_0 and Iron loss are calculated from the OC test results as

Core resistance $$R_0 = \frac{V_0}{I_w} = \frac{V_0}{I_0 \cos\phi_0}$$

Magnetizing reactance $$X_0 = \frac{V_0}{I_m} = \frac{V_0}{I_0 \sin\phi_0}$$

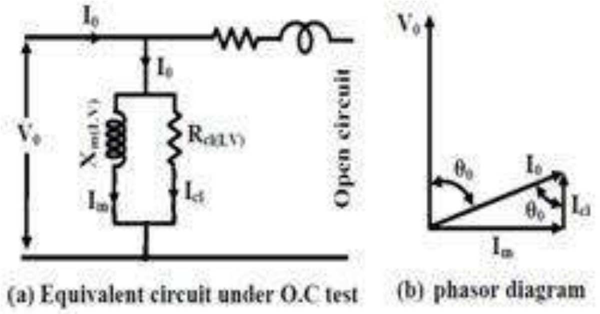


Figure 2.2: Equivalent circuit & phasor diagram during O.C test

Where $\cos\phi_0 = \frac{P_0}{V_0 I_0}$

and iron loss $W_i = P_0$ (No load input power

Short Circuit Test:

1. The SC test is performed on HV side at rated current and LV side is kept Shorted.
2. As the test is conducted on HV side the meters selected will be at low range values like smaller voltmeter, smaller ammeter and unity pf wattmeter
3. As the voltage required to circulate the short circuit rated current is very small about 10 to 15% of the rated HV voltage, so the voltmeter required here will be smaller range even the test is conducted on HV side.
4. The voltmeter, ammeter and the wattmeter readings Vsc, Isc and Wsc respectively are noted by passing rated current on HV side.
5. The wattmeter will record thecopper loss corresponding to the Isc.

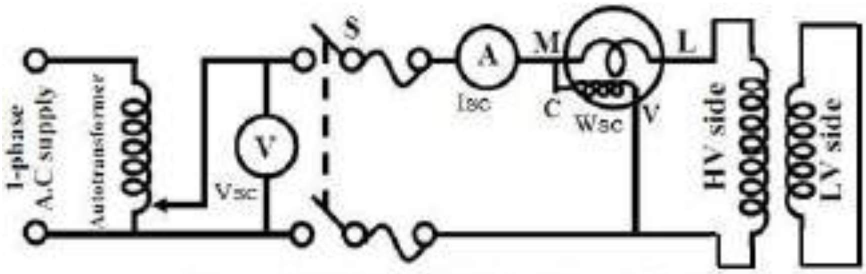


Figure 2.3 : Circuit diagram for S.C test

VOLTAGE REGULATION

Voltage regulation is defined as the percentage change in the output voltage from no-load to full-load expressed in full load voltage.

EFFICIENCY

The Efficiency of the transformer is defined as the ratio of power output to the input power.

$$\eta = \frac{\text{output power}}{\text{input power}} = \frac{\text{output power}}{\text{output power} + \text{losses}}$$

$$\eta = \frac{\text{output power}}{\text{output power} + \text{iron losses} + \text{copper losses}}$$

$$\eta = \frac{V_2 I_2 Cos\varphi_2}{V_2 I_2 Cos\varphi_2 + P_i + P_c}$$

Where,

V_2 = Secondary terminal voltage

I_2 = Full load secondary current in A

$Cos\phi_2$ = power factor of the load

P_i = Iron losses

= hysteresis losses + eddy current loss

Pc = Full load copper losses = $I_2^2 R_{eq}$

Also, the efficiency at any amount of load(x) is given by

$$\eta = \frac{outputinwatts}{inputinwatts} = \frac{xVA\cos\phi}{xVA\cos\phi + W_i + x^2 W_{FLCu}} \times 100$$

Condition for maximum efficiency in the transformer:

$$\eta = \frac{outputinwatts}{inputinwatts} = \frac{V_2 I_2 \cos\phi}{V_2 I_2 \cos\phi + W_i + I_2^2 r_{e2}} = \frac{1}{1 + \frac{W_i}{V_2 I_2 \cos\phi} + \frac{I_2^2 r_{e2}}{V_2 I_2 \cos\phi}} = \frac{1}{1 + \frac{W_i}{V_2 I_2 \cos\phi} + \frac{I_2 r_{e2}}{V_2 \cos\phi}}$$

To get the maximum efficiency the denominator must be small, therefore condition to be the denominator minimum is

$$\frac{d\left(1 + \frac{W_i}{V_2 I_2 \cos\phi} + \frac{I_2 r_{e2}}{V_2 \cos\phi}\right)}{dI_2} = 0$$

$$\frac{d\left(1 + \frac{W_i}{V_2 I_2 \cos\phi} + \frac{I_2 r_{e2}}{V_2 \cos\phi}\right)}{dI_2} = 0 + \left((-)\frac{W_i}{V_2 I_2^2 \cos\phi}\right) + \left(\frac{r_{e2}}{V_2 \cos\phi}\right) = 0$$

$$\frac{r_{e2}}{V_2 \cos\phi} = \frac{W_i}{V_2 I_2^2 \cos\phi} \qquad r_{e2} = \frac{W_i}{I_2^2} \qquad I_2^2 r_{e2} = W_i$$

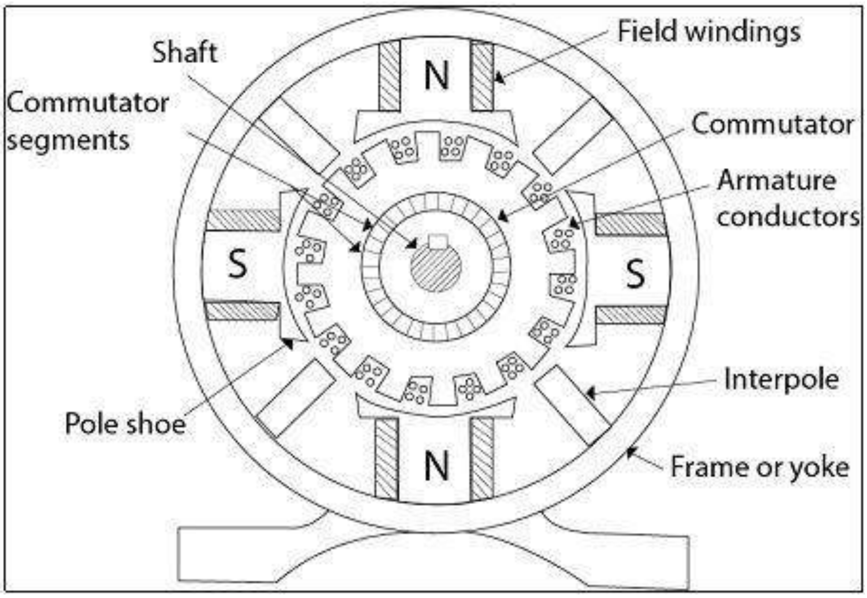
APPLICATION OF A TRANSFORMER

1. It is used to increase or decrease the alternating voltages in electric power applications.
2. The transformer used for impedance matching.
3. The transformer used for isolate two circuits electrically.
4. The transformer used in rectifier.
5. It is used in voltage regulators, voltage stabilizers, power supplies etc.

UNIT - IV ELECTRICAL MACHINES

CONSTRUCTION OF DC GENERATOR

A DC generator has the following parts
1. Yoke (or) Magnetic frame 2. Armature
3. Field winding (or) Pole coils 4. Commutator 5. Brushes



Yoke:

- Yoke or the outer frame of DC generator serves two purposes,
    1. It holds the magnetic pole cores of the generator and acts as cover of the generator.
    2. It carries the magnetic field flux.

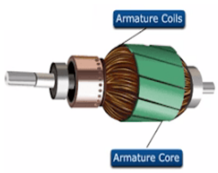
Field winding (or) Pole coils

- The function of the field system is to produce uniform magnetic field within which the armature rotates.
- Field coils are mounted on the poles and carry the dc exciting current.

Armature winding

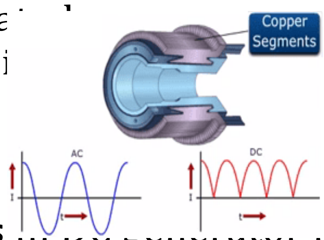
- There are two types of armature winding based on the connection to the Commutator they are

(a) Lap winding (b) Wave winding



Commutator

- A Commutator is a mechanical rectifier which converts the alternating voltage genera
in the armature winding i
direct voltage across
brushes



Brushes

- The function of the brushes i... is to collect current from Commutator segments.
- The brushes are made of carbon and rest on the Commutator.
- The brush pressure is adjusted by means of adjustable springs.

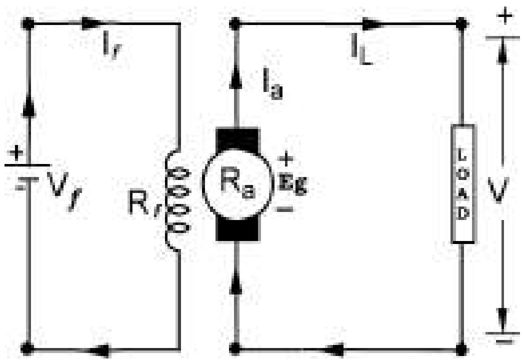
TYPES OF DC GENERATORS

Based on the excitation given to the field winding, the dc generators are classified in to two types

a. Separately excited dc generator
b. Self excited dc generator

SEPARATELY EXCITED DC GENERATOR:

In a separately excited generator field winding is energized from a separate voltage source in order to produce flux in the machine and is shown in the below figure.



1. The flux produced will be proportional to the field current in unsaturated condition of the poles.
2. The armature conductors when rotated in this field will cuts the magnetic flux and generates the emf (Eg).
3. The emf will circulate the current against the armature resistance (Ra), brushes and to the load.
4. Applying KVL to the armature loop the Eg is
$E_g = V + I_a R_a + V_{brush}$

SELF EXCITED DC GENERATOR:

1. In self excited generator field winding is energized from the armature induced emf and there is an electrical connection in between this armature and field winding.
2. There are three possibilities of connecting the field winding to the armature

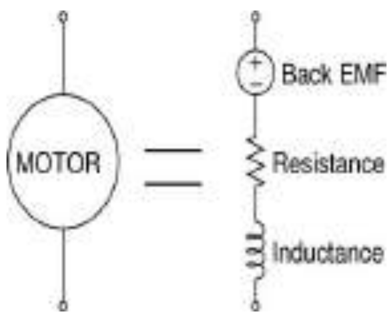
they are

a. Shunt generator
b. Series generator
c. Compound generator
    i. Long shunt compound generator
    ii. Short shunt compound generator

WORKING PRINCIPLE OF DC MOTOR

- A dc motor is a electro mechanical energy conversion device that converts *electrical energy into mechanical energy.*
- Its operation is based on the principle that ***"when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force"***.
- The direction of the force is given by Fleming's left hand rule which states that " Stretch the first three fingers of left hand mutually perpendicular to each other in such a way that central finger indicates the direction of the current in the conductor, fore finger in the direction of the magnetic field, then the thumb indicates the direction of the force developed on the conductor The magnitude of the force developed on the conductor is $F = BIL \sin\theta$

BACK EMF



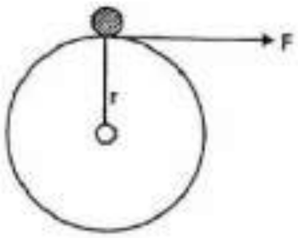
When the armature of a d.c. motor rotates under the influence of the driving torque, the armature conductors move through the magnetic field and hence an e.m.f. is induced in them as per Faradays laws of electromagnetic induction.

This induced e.m.f. acts in opposite direction to the applied voltage V (Lenz's law) and is known as back or counter e.m.f. E_b .

ARMATURE TORQUE OF A DC MOTOR

Torque is the turning and twisting moment of a force about an axis and is measured by the product of force (F) and radius (r) at right angle to which the force acts i.e T = F*r

Let



T = Torque developed on the rotor of the motor in Nm

Φ = Flux per pole in weber

Z = No. of the armature conductors I_a= Armature current in A

P = No. of poles

A = No. of Parallel paths

r = radius of the pulley in mts

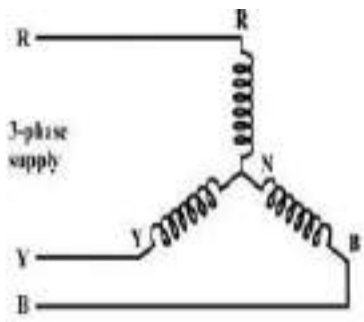
Work done by the pulley, W= Force * distance = F * 2πr

CONSTRUCTION OF A THREE-PHASE INDUCTION MOTOR

The 3-Phase induction motor consists of mainly two parts namely,

1. Stator.
2. Rotor.

1. Stator: The stator consists of



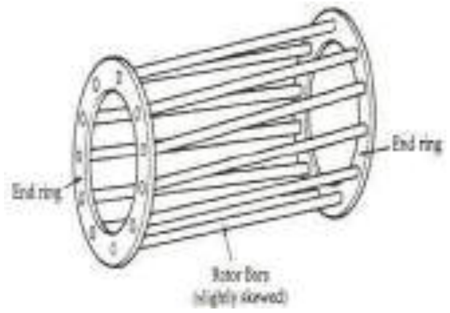
i. Stator frame: The stator frame is made of cast iron and consistsof cooling fins. It gives the support and protects other parts of the motor.

ii. Stator core: The stator core is made of with laminated high grade alloy steel stampings and slotted on the inner periphery and these stampings are insulated.

iii. Stator winding: The stator winding is placed in the stator core, which is connected either in star or delta

2. Rotor

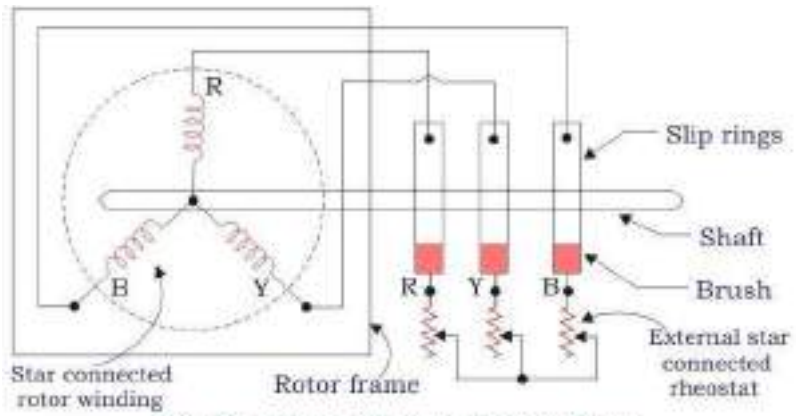
i. Squirrel cage Rotor



The rotor core is a cylindrical one built from a high grade alloy steel laminations. It consists of rotor slots in parallel to the shaft axis on the outer periphery. In general the slots are not parallel to the shaft but skewed with some angle to the shat.

The purpose of the skewing is to prevent interlocking and to reduce the humming noise. The rotor copper bars are placed in the rotor slots and the bars are short circuited with end rings. In Cage rotor type there is no chance of adding the external resistance to the rotor to improve the torque developed at starting.

ii. Slip ring rotor (or) Phase Wound rotor



Slip Ring Three Phase Induction Motor

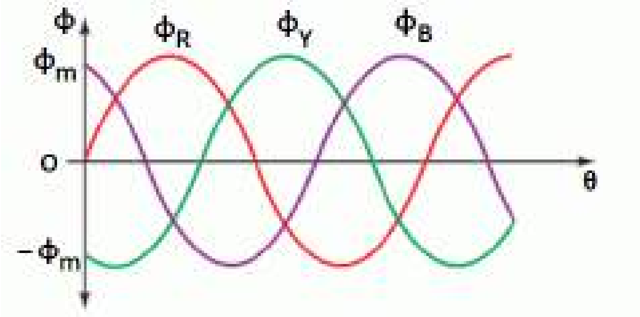
The rotor core is a cylindrical one built from a high grade alloy steel laminations. It consists of rotor slots on the outer periphery where the star connected winding is done. The star connected rotor winding is done for the same poles as that of the stator winding. The ends of the star connected rotor winding are connected to the three slip rings placed on the shaft. The carbon brushes are mounted on the slip rings, through which an external resistance is added to the rotor. The advantage of the Wound rotor is the starting torque is improved by adding the external resistance to the rotor using slip rings.

Rotating Magnetic Field

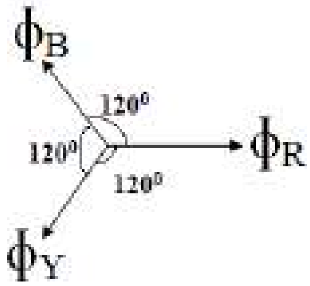
The induction motor rotates due to the rotating magnetic field in 3 phase induction motor, which is produced by the stator winding in the air gap between in the stator and the rotor. The stator hasa three phase stationary winding which can be either star connected or delta connected.

Whenever the AC supply is connected to the stator windings, line currents IR, IY, and IB start flowing. These line currents havephase difference of 120^{o} with respect to each other. Due to each line current, a sinusoidal flux is produced in the air gap.

These fluxes have the same frequency as that of the line currents, and they also have the same phase difference of 120^{o} with respect to each other. Let the flux produced by the line currents IR, IB, IY be φR, φB, φY respectively



Fluxes produced by line currents



Mathematically, they are represented as follows:

$$\varphi_R = \varphi_m \sin \omega t = \varphi_m \sin \theta$$
$$\varphi_Y = \varphi_m \sin (\omega t - 120^o) = \varphi_m \sin (\theta - 120^o)$$
$$\varphi_B = \varphi_m \sin (\omega t - 240^o) = \varphi_m \sin (\theta - 240^o)$$

The effective or total flux (ϕ_T) in the air gap is equal to the phasor sum of the three components of fluxes ϕ_R, ϕ_Y and, ϕ_B.

Therefore, $\phi_T = \phi_R + \phi_Y + \phi_B$

Step 1: The values of total flux ϕ_T for different values of θ such as 0, 60, 120 , 180 ….. 360°. are to be calculated

Step 2: For every value of θ in step 1, draw the phasor diagram, with the phasor ϕ_R as the reference phasor i.e. all the angles are drawn with respect to this phasor.

For θ = 0°

$\varphi_R = \varphi_m \sin \omega t = \varphi_m \sin \theta = 0$

$\varphi_Y = \varphi_m \sin (\omega t - 120^o) = \varphi_m \sin (\theta - 120^o) = \varphi_m \sin (0 - 120^o) = (-)\varphi_m \sin 120^o = -0.866\ \varphi_m$

$\varphi_B = \varphi_m \sin (\omega t - 240^o) = \varphi_m \sin (\theta - 240^o) = \varphi_m \sin (0 - 240^o) = (-)\varphi_m \sin 240^o = 0.866\ \varphi_m$

Therefore, $\phi_T = 0 + \phi_Y + \phi_B = \phi_T = 0 + (-\phi_Y) + \phi_B$

$$\Phi_T = \sqrt{(\Phi_Y)^2 + (\Phi_B)^2 + 2\Phi_Y\Phi_B\cos 60}$$

$$\Phi_T = \sqrt{\left(\frac{\sqrt{3}}{2}\varphi_m\right)^2 + \left(\frac{\sqrt{3}}{2}\varphi_m\right)^2 + 2\times\left(\frac{\sqrt{3}}{2}\varphi_m\right)\times\left(\frac{\sqrt{3}}{2}\varphi_m\right)\times\frac{1}{2}}$$

$$\Phi_T = \sqrt{3\times\left(\frac{\sqrt{3}}{2}\varphi_m\right)^2} = \frac{3}{2}\varphi_m = 1.5\varphi_m$$

In the similar way as shown in the phasor diagrams the resultant or total flux rotates 60 degrees for every instant and completes one cycle of rotation in the direction of phase sequence of the supply.

Thus when a three phase supply is applied to the three phase winding connected either in star or delta it produces a rotating magnetic field having

1. a constant magnitude of 1.5 times the Φm
2. a constant speed of synchronous speed Ns=120f/P
3. a direction equal to its phase sequence.

WORKING OF A THREE-PHASE INDUCTION MOTOR

The balanced three-phase winding of the stator is supplied with a balanced three-phase voltage. The current in the stator winding produces a rotating magnetic field, with constant magnitude of 1.5Øm and rotates at synchronous speed of Ns=120f/P

The magnetic flux lines in the air gap cut both stator and rotor (being stationary, as the motor speed is zero) conductors at the same speed. The emfs in both stator and rotor conductors are induced at the same frequency, i.e. line or supply frequency, with No. of poles for both stator and rotor windings (assuming wound one) being same.

As the rotor winding is short-circuited at the slip-rings, current flows in the rotor windings. The electromagnetic torque in the motor is in the same direction as that of the rotating magnetic field, due to the interaction between the rotating flux produced in the air gap by the current in the stator winding, and the current in the rotor winding.

This is as per Lenz's law, as the developed torque is in such direction that it will oppose the cause, which results in the current flowing in the rotor winding. As the rotor starts rotating in the same direction, as that of the rotating magnetic field due to production of the torque as stated earlier, the relative velocity decreases, along with lower values of induced emf and current in the rotor.

If the rotor speed is equal that of the rotating magnetic field, which is termed as synchronous speed, and also in the same direction, the relative velocity is zero, which causes both the induced emf

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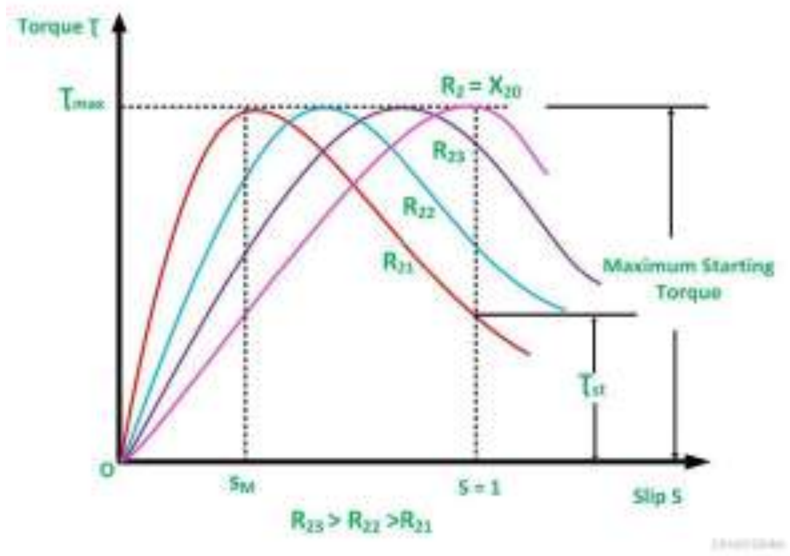
and current in the rotor to be reduced to zero. Under this condition, torque will not be produced. So, for production of positive (motoring) torque, the rotor speed must always be lower than the synchronous speed. The rotor speed is never equal to the synchronous speed in an IM.

<u>SIGNIFICANCE OF TORQUE-SLIP CHARACTERISTIC</u>

1. The torque-slip characteristics in an induction motor shows the variation of the torque developed with respect to changes of slip.
2. When the load on the motor is removed gradually the speed increases and the slip decreases.
3. Considering, the speed at standstill Nr = 0 the slip s =1 and as the

speed increases from 0 to Ns the slip s decreases from 1 to zero, any how the induction motor never rotates at Ns so the slip never becomes 0.

4. For the smaller values of slips i.e 0 < s < sm, sX2 << R2 so neglecting sX2, the torque in this smaller range of slips is
5. As the torque is directly proportional to slip s, Therefore as slip increases the torque increases linearly and attains maximum torque when slip s = sm
6. For the larger values of slips i.e sm < s < 1, R2 << sX2 so neglecting R2, the torque in this larger range of slips is 8. As the torque is inversely proportional to slip s, Therefore as slip increases the torque decreases linearly and falls to the value of standstill torque Tst at s = 1



$$T = \left(\frac{3}{2\pi n_s}\right)\frac{sE_2^2 R_2}{R_2^2 + (sX_2)^2} \quad T\alpha\frac{sR_2}{R_2^2 + (sX_2)^2}$$

7. For the smaller values of slips i.e $0 < s < sm$, $sX_2 << R_2$ so neglecting sX_2, the torque in this smaller range of slips is

$$T\alpha\frac{sR_2}{R_2^2} \quad T\alpha\frac{s}{R_2} \quad T\alpha\, s$$

8. As the torque is directly proportional to slip s, Therefore as slip increases the torque increases linearly and attains maximum torque when slip s = sm
9. For the larger values of slips i.e $sm < s < 1$, $R_2 << sX_2$ so neglecting R_2, the torque in this larger range of slips is

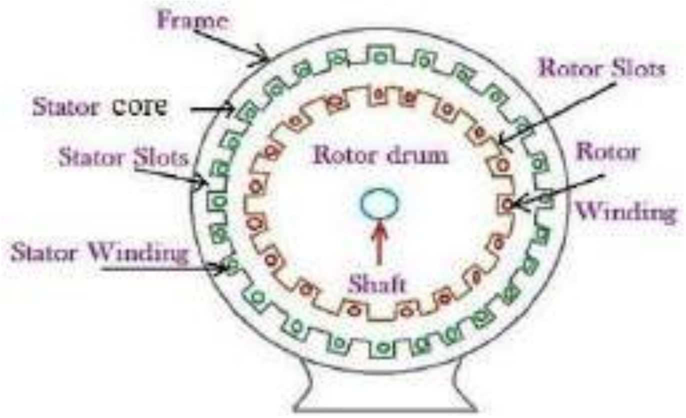
$$T\alpha\frac{R_2}{sX_2^2} \quad T\alpha\frac{1}{s}$$

10. As the torque is inversely proportional to slip s, Therefore as slip increases the torque decreases linearly and falls to the value of standstill torque Tst at s = 1

SINGLE-PHASE INDUCTION MOTOR

Construction

A typical motor consists of two parts namely stator and rotor like other type of motors. An outside stationary stator having coils supplied with AC current to produce a rotating magnetic field, An inside rotor attached to the output shaft that is given a torque by the rotating field.



Stator construction

The stator of an induction motor is laminated iron core with slots. Coils are placed in the slots to form a three or single phase winding.

1. Stator Frame: It is the outer part of the three-phase induction motor. Its main function is to support the stator core and stator winding. It acts as a covering and provides protection and mechanical strength to all the inner parts of the machine. The frame is either made up of die-cast or fabricated steel.

2. Stator Core: The main function of the stator core is to carry alternating flux. In order to reduce the eddy current losses the stator core is laminated. This laminated type of structure is made up of stamping which is about 0.4 to 0.5 mm thick. All the stamping are stamped together to form stator core, which is then housed in stator frame. The stampings are generally made up of silicon steel, which reduces the hysteresis loss.

3. Stator Winding: The slots on the periphery of stator core of the three phase induction motor carries three phase windings. This three phase winding is supplied by three phase ac supply. The three phases of the winding are connected either in star or delta depending upon which type of starting method is used.

Rotor construction

Type of rotors Rotor is of two different types.

1. Squirrel cage rotor.
2. Wound rotor.

1. Squirrel cage rotor

In the squirrel-cage rotor, the rotor winding consists of single copper or aluminum bars placed in the slots and short-circuited by end-rings on both sides of the rotor. Most of single phaseinduction motors have Squirrel-Cage rotor. One or 2 fans are attached to the shaft in the sides of rotor to cool the circuit.

Figure: Squirrel cage rotor

2. Wound Rotor

In the wound rotor, an insulated 3-phase winding similar to the stator winding wound for the same number of poles as stator, is placed in the rotor slots. The ends of the star-connected rotor winding are brought to three slip rings on the shaft so that a connection can be made to it for starting or speed control. It is usually for large 3 phase induction motors. Rotor has a winding the same as stator and the end of each phase is connected to a slipring. Compared to squirrel cage rotors, wound rotor motors are expensive and require maintenance of the slip rings and brushes, so it is not so common in industry applications.

Slip rings and brushes: Their sole purpose is to allow resistance to be placed in series with the rotor windings while starting.

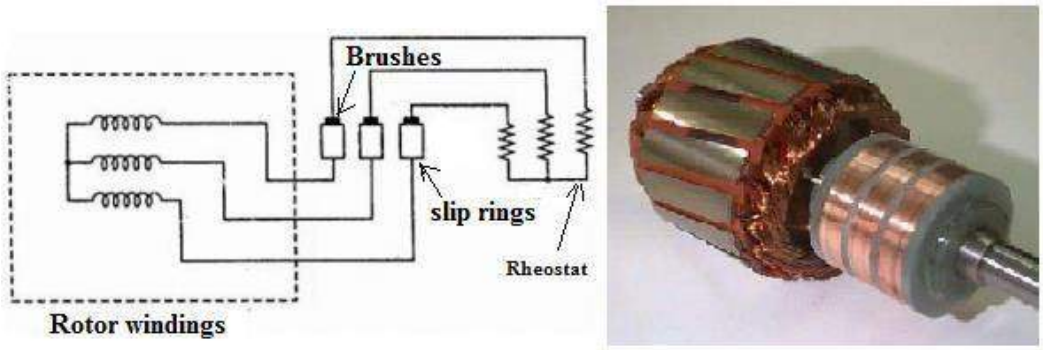


Fig: Slip ring Rotor Basic

Working Principle of an Induction Motor

In a DC motor, supply is needed to be given for the stator winding as well as the rotor winding. But in an induction motor only the stator winding is fed with an AC supply. Alternating flux is produced around the stator winding due to AC supply. This alternating flux revolves with synchronous speed. The revolving flux is called as "Rotating Magnetic Field" (RMF).

The relative speed between stator RMF and rotor conductors causes an induced emf in the rotor conductors, according to theFaraday's law of electromagnetic induction. The rotor conductorsare short circuited, and hence rotor current is produced due to induced emf. That is why such motors are called as induction motors. The direction of induced rotor current, according to Lenz's law, is such that it will tend to oppose the cause of its production.

As the cause of production of rotor current is the relative velocity between rotating stator flux and the rotor, the rotor will try to catch up with the stator RMF. Thus the rotor rotates in the same direction as that of stator flux to minimize the relative velocity.

However, the rotor never succeeds in catching up the synchronous speed. This is the basic working principle of induction motor of either type, single phase or 3 phase.

Application of Induction Motor

1. **Squirrel cage Rotor:** Many Squirrel cage induction motors are available in the market to meet the demand of the several industrial applications and various starting and running condition requirement.
2. **Wound rotor motors**
   i. Wound rotor motors are suitable for loads requiring high starting torque and where a lower starting current is required.
   ii. Used for the loads that require speed control.
   iii. The wound rotor induction motors are used in conveyors, cranes, pumps, elevators and compressors.
   iv. The maximum torque is above 200 percent of the full load value. The efficiency is about 90 %.

ALTERNATOR - WORKING PRINCIPLE

- Synchronous generator or AC generator is a device which converts mechanical power in the form of A.C.
- It works on the principle of ELECTRO MAGNETIC INDUCTION and it is also called as Alternator.
- An alternator consists of armature winding and field magnet, but the difference between the alternator and DC generator is that in the DC generator armature rotates and the field system is stationary.
- This arrangement in the alternator is just reverse of it, the

armature is stationary called as stator and field system is rotating called as Rotor.

For generating EMF, three things are essential:

1) Magnetic field
2) System of conductors
3) Relative motion between those two.

- The conductors are mounted on the stator and the field poles are mounted on the Rotor core
- Relative motion between the stator conductors and the field is brought about rotating the field system.
- The rotor is coupled mechanically to a suitable prime mover. When the prime mover runs, the rotor core also rotates and the field flux is cut by the stationary stator conductors and emf's are induced in them.
- If a load is connected across the stator terminals electric power would be delivered to it.

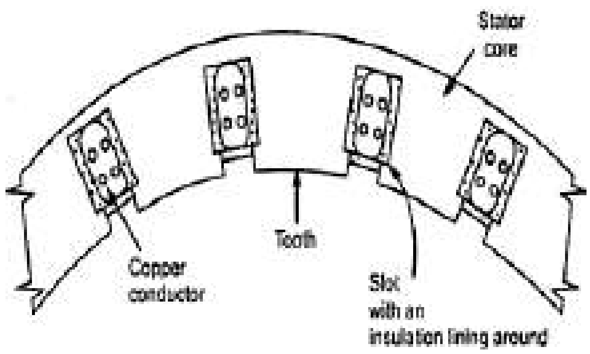
CONSTRUCTION

An alternator consists of mainly two parts

1. Stator
2. Rotor

Stator:

1. The armature core is supported by the stator frame and is built up of laminations of special magnetic iron or steel iron alloy, the core is laminated to minimize the loss due to Eddy currents.
2. The laminations are stamped out in complete rings or segments. The laminations are insulated from each other and have space between them for allowing the cooling air to pass through.



3. The inner periphery of the stator is slotted and copper

conductors which are joined to one another constituting armature winding housed in these slots.

4. The other ends of the winding are brought out are connected to fixed terminal from which the generator power can be taken out.
5. Different shapes of the armature slots are available
   a. The wide open type slot also used in DC machines has the advantage of permitting easy installation of form-wound colis and there easy removal in case of repair but it has the disadvantage of distributing the air gaps flux into bunches that produce ripples in the wave of generated EMF.
   b. The semi closed type slots are better in this respect but do not allow the use of form wound coils.
   c. The fully closed slots do not disturb the air gap flux but they try to increase the inductance of the windings. The armature conductors have to be threaded through, thereby increasing the initial labour and cost of the winding. Hence, these are rarely used.

Rotor

Depending upon the type of application, these are classified into two types

1. Salient-pole or projecting pole type
2. Non silent-pole or round rotor or cylindrical rotor

UNIT – V

ELECTRICAL INSTALLATIONS

COMPONENTS OF LT SWITCHGEAR

Switchgear

The apparatus used for switching, controlling and protecting the electrical circuits and equipment is known as switch gear.

Switch gear Equipment

1. Switches (air break type).
2. Fuses.
3. Circuit breakers.
4. Relays.
5. Isolators.
6. Current and potential transformer.
7. Lightning arresters.

1. Switches: In electrical system, a switch is a device, which can make or break an electrical circuit automatically or manually. In other words, an electrical switch is a controlling device, which interrupts the flow of current.

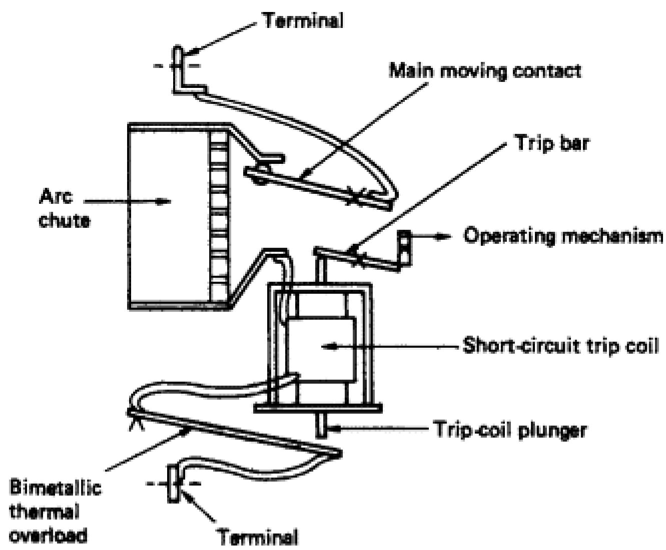
2. Fuses: The electrical equipment are designed to carry a particular rated value of current under normal conditions.

Under abnormal conditions such as short circuits, overload, or any fault; the current rises above this value, damaging the equipment and sometimes resulting in fire hazard. Fuses come into operation under fault conditions.

MINIATURE CIRCUIT BREAKER (MCB)

A miniature circuit breaker automatically switches off electrical circuit during an abnormal condition of the network means in overload condition as well as faulty condition. Nowadays we use an MCB in low voltage electrical network instead of fuse. The fuse may not sense it but the miniature circuit breaker does it in a more reliable way. MCB is much more sensitive to overcurrent than fuse.

Fig- MCB



Advantages

The MCB has some advantages compared to fuse:

1. It automatically switches off the electrical circuit during abnormal condition of the network means in over load condition as well as faulty condition. The fuse does not sense but miniature circuit breaker does it in more reliable way. MCB is much more sensitive to over current than fuse.
2. Another advantage is, as the switch operating knob comes at its off position during tripping, the faulty zone of the electrical circuit can easily be identified. But in case of fuse, fuse wire should be checked by opening fuse grip or cutout from fuse base, for confirming the blow of fuse wire.
3. Quick restoration of supply can not be possible in case of fuse as because fuses have to be rewirable or replaced for restoring the supply. But in the case of MCB, quick restoration is possible by just switching on operation.
4. Handling MCB is more electrically safe than fuse. Because of too many advantages of MCB over fuse units, in modern low voltage electrical network, miniature circuit breaker (MCB) is mostly used instead of backdated fuse unit.

Disadvantage

Only one disadvantage of MCB over fuse is that this system is more costly than fuse unit system.

Safety precautions in Handling Electrical Appliance

It is essentially important to take precautions when we are working with electricity and using electrical appliances. Here, some of the basic precautions are mentioned for safe usage of electrical appliance:

1. **Follow the manufacture's instructions:** Always read the manufacture's instructions carefully before using a new appliance.
2. **Replace or repair damaged power cords:** Exposed wiring is a danger that cannot be ignored. If you see the protective coating on a wire is stripped away, be sure to replace it or cover it with electrical tape as soon as possible.
3. **Keep electrical equipment or outlets away from water:** Avoid water at all times when working with electricity. Never touch or repairing any electrical equipment or circuits with wet hands. It increases the conductivity of electrical current. Keep all electrical appliance away from water such as sinks, bathtubs, pools or overhead vents that may drip.
4. **Use insulated tools while working:** Always use appropriate insulated rubber gloves, goggles, protective clothes and shoes with insulated soles while working on any branch circuits or any other electrical circuits. Use only tools and equipment with non-conducting handles when working on electrical devices. Never use metallic pencils or rulers or wear rings or metal watchbands when working with electrical equipment as they cause a strong electric shock.
5. **Don't overload your outlets:** Every outlet in your home is designed to deliver a certain amount of electricity; by plugging too many devices into it at once, you could cause a small explosion or a fire. If you have a lot of things to plug in, use a power strip that can safely accommodate your needs.
6. **Shut-off the power supply:** Always make sure that the power source should be shut-off before performing any work

related to electricity. For example; inspecting, installing, maintaining or repairing.

7. **Avoid extension cords as much as possible:** Running extension cords through the house can trip up residence; this can cause injury and damage to the wire or outlet if it cause the cord to be ripped out of the wall. If you find yourself using extension cords very often, consider having an electrician install new outlets throughout your home.
8. **When to repair:** Everyone want to have the safe electrical environment. Equipment producing "tingle" sound should be disconnected and reported promptly for repair.
9. **Avoid the usage of flammable liquids:** Never use highly flammable liquids near electrical equipment. Never touch another person's equipment or electrical control devices unless instructed to do so.
10. **Use electric tester:** Never try repairing energized equipment. Always check that it is de-energized first by using a tester. When an electric tester touches a live or hot wire, the bulb inside the tester lights up showing that an electrical current is flowing through the respective wire. Check all the wires, the outer metallic covering of the service panel any other hanging wires with an electrical tester before proceeding with your work.
11. **In case of electric shock:** If an individual comes in contact with a live electrical conductor, do not touch the equipment, cord person. Disconnect the power source from the circuits breaker or pull out the plug using a leather belt. By enclosing all electric conductors and contacts can save people from getting the electric shock. Use three-pin plugs,

which have earth wire connection which prevents electrical shock.

12. **Display danger board:** Danger board should be displayed at the work place. We should not allow any unauthorized person to enter in the working place and we

should not put any new equipment into the service without necessary testing by the concern authority.

13. **Usage of proper ladder:** Never use an aluminium or steel ladder if you are working on any receptacle at height in your home. An electrical surge will ground you and the whole electric current will pass through your body. Use a bamboo, wooden or a fibreglass ladder instead.

14. **Usage of circuits breaker or fuse:** Always use a circuits breaker or fuse with the appropriate current rating. Circuits breakers and fuses are protection devices that automatically disconnect the live wire a condition of short circuits or over current occurs. The selection of the appropriate fuse or circuit breaker is essential. Normally for protection against short circuits a fuse rated of 150% of the normal circuit current is selected. In the case of a circuit with 10 amperes of current, a 15 ampere fuse will against direct short circuits a 9.5 amperes fuse will blow out.

15. **Use ceiling on live wire:** Always put a cap on the hot/live wire while working on an electric board or service panel as you could end up short circuiting the bare ends ofthe live wire with the neutral. The cap insulates the copper ends of the cable thus preventing any kind of shock even if touched mistakenly.

16. **Precaution during soldering:** Always take care while soldering your circuits boards. Wear goggles and keep yourself away from the fumes. Keep the solder iron in its stand when not in use; it can get extremely hot and can easily cause burns.

17. **Things to remember:** The circuits is bad, electricity appliances are not working well, and lights are fluctuating. It means you need an electrical inspection or repair. In this case, either you'll call an electrician or do it yourself. So if you are trying to repair, always remember that your hands are well dry, you have essential tools, rubber gloves & shoe are good, As all these acts as an insulator. Do not wear loose clothing or tied near electrical equipment.

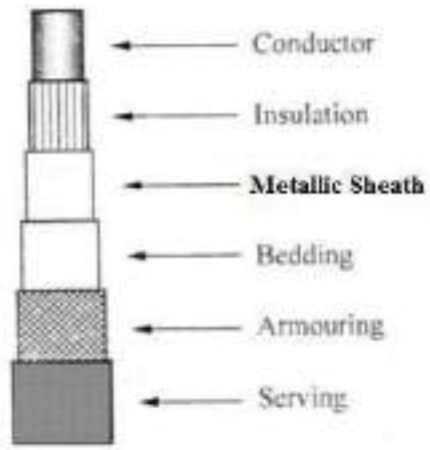
18. Keep heaters away from bedclothes, clothing and curtains to avoid risk fire. Be extra careful when using electrical appliances attached to power outlets near kitchen or bathroom sinks, tubs, swimming pools, and other wet areas. Don't cover an electric heater with clothing or other items.

<u>TYPES OF WIRES AND CABLES</u>

The size & type of wire/cable must suit the power rating required for their use. Various types of wires are used for electrical wiring. The commonly used types are:

1. **V.I.R. (Vulcanized India Rubber) wires:** These types of wires consist of a tinned conductor coated with rubber insulation. The thickness of rubber varies with the voltagefor which the wire is designed i.e., 250 or 660 volts. This rubber insulation is not moisture or heatproof.
2. **C.T.S. (Cable Type Sheathed) wires:** In this type, ordinary insulated conductors are provided with an additional tough rubber sheath. This also provides a protection against moisture, chemical fumes and tear.

3. **P.V.C (Poly vinyl chloride):** These are the most commonly used wires. These have conductors with P.V.C insulation. PVC is non- – hygroscopic. However, PVC softens at high temperature and hence is not used where extremes of temperature occur e.g. in heating appliances.
4. **Cables:** These consist of individually insulated conductors which are put together inside a protective mechanical covering. The construction of cable is as follows:



Conductor or Core: Each cable has one central core or a number of cores (2, 3, 3 1/2 or 4) which are normally made up of tinned copper or aluminum conductor. Stranding gives flexibility to the cable.

Insulation: Commonly used insulating materials are varnished cambric, vulcanized bitumen or impregnated paper. Impregnated paper is invariably used for higher voltage cable.

Metallic Sheath: Usually, a lead alloy or aluminum sheath is provided over the insulation for providing mechanical protection and preventing entry of moisture in the insulation.

Bedding: The bedding consists of a layer of fibrous material like jute. In order to reduce the mechanical stress on the insulating material the bedding is employed.

Armouring: This layer usually consists of one or two layers of galvanized steel tape and is provided to protect the cable from mechanical injury during transportation or during unloading or during laying of the cable.

Serving: A layer of fibrous material like jute cloth is provided over the armouring to protect it from atmospheric condition. This layer is known as serving.

EARTHING OR EARTHING OF GROUNDING OR ELECTRICAL EARTHING

Definition

The process of transferring the immediate discharge of the electrical energy directly to the earth by the help of the low resistance wire is known as the electrical earthing. The electrical earthing is done by connecting the non-current carrying conductive part of the equipment to the ground.

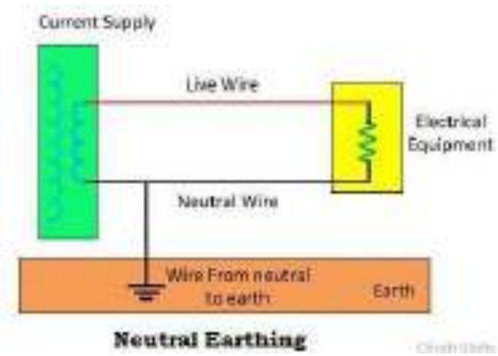
Types of Electrical Earthing

The electrical equipment mainly consists of two non-current carrying parts. These parts are neutral of the system or frame of the electrical equipment. From the earthing of these two non current carrying parts of the electrical system earthing can be classified into two types:

1. Neutral Earthing.
2. Equipment Earthing.

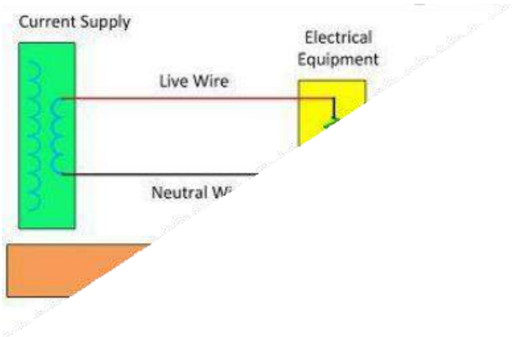
1. Neutral Earthing

In neutral earthing, the neutral of the system is directly connected to earth by the help of the GI wire. The neutral earthing is also called the system earthing. Such type of earthing is mostly provided to the system which has star winding. For example, the neutral earthing is provided in the generator, transformer, motor etc.



2. Equipment Earthing

Such type of earthing is provided to the electrical equipment. The non-current carrying part of the equipment like their metallic frame is connected to the earth by the help of the conducting wire. If any fault occurs in the apparatus, the short-circuit current to pass the earth by the help of wire. Thus, protect the system from damage.



TYPES OF BATTERIES

A cell is a single unit that converts chemical energy into electrical energy, and a battery is a collection of cells.

Types of Batteries

Batteries generally can be classified into different categories and types, ranging from chemical composition, size, form factor and use cases, but under all of these are two major battery types:

1. Primary Batteries.
2. Secondary Batteries.

1. Primary Batteries

Primary batteries are batteries that cannot be recharged once depleted. Primary batteries are made of electrochemical cellswhose electrochemical reaction cannot be reversed.

Primary batteries exist in different forms ranging from coin cells to AA batteries. They are commonly used in standalone applications where charging is impractical or impossible. A good example of which is in military grade devices and battery powered equipment.

Some other examples of devices using primary batteries include; Pace makers, Animal trackers, Wrist watches, remote controls and children toys to mention a few.

The most popular type of primary batteries are alkaline batteries. They have a high specific energy and are environmentally friendly, cost-effective and do not leak even when fully discharged. They can be stored for several years, have a good safety record and can be carried on an aircraft without being subject to UN Transport and other regulations. The only downside to alkaline batteries is the low load current, which limits its use to devices with low current requirements like remote controls, flashlights and portable entertainment devices.

2. Secondary Batteries

Secondary batteries are batteries with electrochemical cells whose chemical reactions can be reversed by applying a certain voltage to the battery in the reversed direction. Also referred to as rechargeable batteries, secondary cells unlike primary cells can be recharged after the energy on the battery has been used up.

They are typically used in high drain applications and other scenarios where it will be either too expensive or impracticable to use single charge batteries. Small capacity secondary batteries are used to power portable electronic devices like mobile phones, and other gadgets and appliances while heavy-duty batteries are used in powering diverse electric vehicles. They are also used as standalone power sources alongside Inverters to supply electricity. Although the initial cost of acquiring rechargeable batteries is always a whole lot higher than that of primary batteries but they are the most cost-effective over the long-term.

Secondary batteries can be further classified into several other types based on their chemistry. This is very important because the chemistry determines some of the attributes of the battery including its specific energy, cycle life, shelf life, and price to mention a few.

There are basically four major chemistries for rechargeable batteries:

i. Nickel Cadmium (Ni-Cd).
ii. Lithium-ion (Li-ion).
iii. Lead-Acid.

IMPORTANT CHARACTERISTICS FOR BATTERIES

There are many characteristics that can help to identify a battery that can help to identify a battery and we can distinguish the three main ones as; chemistry, battery capacity and voltage. However, if the battery is only a starter, it also delivers cold cranking amps (CCA), which permits to offer high current at cold temperatures.

1. **Chemistry:** The main battery chemistries are lead, nickel and lithium. They all need a specific designated charger, thisis why charging these batteries on a different charger from their own might cause an incorrect charge, despite it seeming to work at first. This happens because of the different regulatory requirement of each chemistry.
2. **Battery Capacity:** Battery capacity is a measure (typically in Amp-hr) of the charge stored by the battery, and is determined by the mass of active material contained in the battery. The battery capacity represent the maximum amount of energy that can be extracted from the battery under certain specified conditions.
3. **Voltage:** A battery feature a nominal voltage. Along with the amount of cells connected in series, chemistry provides the open circuits voltage (OCV), which is about 5-7% higher on a

fully charged battery. It is important to check the correct nominal voltage of a battery before connecting it.

4. **Cold Cranking Amps (CCA):** Every starter battery is marked with cold cranking amps, also abbreviated CCA. The number denotes the amount of amps that the battery is able to provide at -18^{0}C.

ELEMENTARY CALCULATIONS FOR ENERGY CONSUMPTION

Energy conservation involves use of lesser energy for the same level of activity. Energy conservation refers to efforts made to reduce energy consumption.

The demand for electricity has been increasing day to day. There is a strong correlation between energy use per person and standard of living, because electricity is the central force behind our productivity and environment. As our resources are fast getting depleted thus energy saving is essential.

Energy conservation can be achieved through increased efficient energy use, in conjunction with decreased energy consumption and/or reduced consumption from conventional energy sources.

Need for energy conservation

Energy conservation means using the energy more efficiently or minimizing wastage of energy. It is important that, any conservation plan should only to try to avoid wastage of energywithout affecting productivity and growth rate.so there is a great need of energy conservation because of the following reason:

1. To save energy to meet the future demand.
2. To minimize energy costs.

3. To make optimization of production and utilization of energy.
4. To improve the efficiency of the system.
5. To invest new effective and efficient equipment to replace in efficient equipment.
6. To bring out new changes in operating methods.

Benefits of energy conservation

The following are some of the benefits by effective implementation of energy conservation.

1. Saving of energy for the future.
2. Saving of fuel for reduction in energy costs.
3. Cheaper and better production of energy.
4. Lesser pollution and preserving of environment.
5. Efficient transmission and distribution systems with lesser maintenance costs.
6. More job opportunities.
7. Application of new technologies with cost effectiveness.
8. Meeting national security and defense requirements.

Example 11.1 The below table shows the various appliances and their times of operation in a residential house. Calculate the monthly (a) energy consumption and (b) electricity bill. Assume the electricity rate as ₹ 5.00 per unit.

S. No.	Appliance name	No.	Rating in watts/unit	Operation time
1	Tubelights	3	40	6 hours
2	PL lamp	2	20	1 hour
3	Window type A/C	2	2000	4 hours
4	Domestic exhaust fan	1	100	3 hours
5	Toaster	1	750	15 mins
6	165 litre fridge	1	150	24 hours

Solution: Electricity consumed per day in kWh, for each appliance is determined as follows by using the common relation $KWh = \frac{\text{No. of appliances} \times \text{rating} \times \text{operation time}}{1000}$

(i) Energy consumption of tubelights $= \frac{3 \times 40 \times 6}{1000} = 0.72$ kWh

(ii) Energy consumption of PL lamps

$$= \frac{\text{No. of lamps} \times \text{rating} \times \text{operation time}}{1000} = \frac{2 \times 20 \times 1}{1000} = 0.04 \text{ kWh}$$

(iii) Energy consumption of window A/Cs $= \dfrac{2 \times 2000 \times 4}{1000} = 16 \text{ kWh}$

(iv) Energy consumption of domestic fan $= \dfrac{1 \times 100 \times 3}{1000} = 0.3 \text{ kWh}$

(v) Energy consumption of toaster $= \dfrac{1 \times 750 \times (15/60)}{1000} = 0.1875 \text{ kWh}$