# JEPPIAAR ENGINEERING COLLEGE
## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

### VISION OF INSTITUTION

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

### MISSION OF INSTITUTION

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

### PROGRAM OUTCOMES (POs)

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

11 **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## VISION OF THE DEPARTMENT

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

## MISSION OF THE DEPARTMENT

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

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

## PROGRAM SPECIFIC OUTCOME (PSOs)

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

**EE8301** **ELECTRICAL MACHINES – I** **LT P C**

**3 1 0 4**

**OBJECTIVES:**

To impart knowledge on the following Topics

- Magnetic-circuit analysis and introduce magnetic materials
- Constructional details, the principle of operation, prediction of performance, the methods of testing the transformers and three phase transformer connections..
- Working principles of electrical machines using the concepts of electromechanical energy conversion principles and derive expressions for generated voltage and torque developed in all Electrical Machines.
- Working principles of DC machines as Generator types, determination of their noload/ load characteristics, starting and methods of speed control of motors.
- Various losses taking place in D.C. Motor and to study the different testing methods to arrive at their performance.

**UNIT I MAGNETIC CIRCUITS AND MAGNETIC MATERIALS 9**

Magnetic circuits –Laws governing magnetic circuits - Flux linkage, Inductance and energy – Statically and Dynamically induced EMF - Torque – Properties of magnetic materials, Hysterisis and Eddy Current losses - AC excitation, introduction to permanent magnets-Transformer as a magnetically coupled circuit.

**UNIT II TRANSFORMERS 9**

Construction – principle of operation – equivalent circuit parameters – phasor diagrams, losses – testing – efficiency and voltage regulation-all day efficiency-Sumpner's test, per unit representation – inrush current - three phase transformers-connections – Scott Connection – Phasing of transformer– parallel operation of three phase transformers-auto transformer – tap changing transformers- tertiary winding.

**UNIT III ELECTROMECHANICAL ENERGY CONVERSION AND CONCEPTS IN ROTATING MACHINES 9**

Energy in magnetic system – Field energy and coenergy-force and torque equations – singly and multiply excited magnetic field systems-mmf of distributed windings – Winding Inductances-, magnetic fields in rotating machines – rotating mmf waves – magnetic saturation and leakage fluxes.

**UNIT IV DC GENERATORS 9**

Construction and components of DC Machine – Principle of operation - Lap and wave windings-EMF equations– circuit model – armature reaction –methods of excitation-commutation and interpoles - compensating winding – characteristics of DC generators.

**UNIT V DC MOTORS 9**

Principle and operations - types of DC Motors – Speed Torque Characteristics of DC Motors-starting and speed control of DC motors –Plugging, dynamic and regenerative braking- testing and efficiency– Retardation test- Swinburne's test and Hopkinson's test - Permanent magnet dc motors(PMDC)-DC Motor applications.

**TOTAL (L: 45+T: 15): 60 PERIODS**

**OUTCOMES:**

- Ability to analyze the magnetic-circuits.
- Ability to acquire the knowledge in constructional details of transformers.
- Ability to understand the concepts of electromechanical energy conversion.
- Ability to acquire the knowledge in working principles of DC Generator.
- Ability to acquire the knowledge in working principles of DC Motor
- Ability to acquire the knowledge in various losses taking place in D.C. Machines

**TEXT BOOKS:**


1. Stephen J. Chapman, 'Electric Machinery Fundamentals'4$^{th}$ edition, McGraw Hill Education Pvt. Ltd, 2010.
2. P.C. Sen 'Principles of Electric Machines and Power Electronics' John Wiley & Sons; 3rd Edition 2013.
3. Nagrath I. J and Kothari D. P. 'Electric Machines', Fourth Edition, Tata McGraw Hill Publishing Company Ltd, 2010.


**REFERENCES:**


1. Theodore Wildi, "Electrical Machines, Drives, and Power Systems", Pearson Education., (5$^{th}$ Edition), 2002.
2. B.R. Gupta,'Fundamental of Electric Machines' New age International Publishers,3rd Edition ,Reprint 2015.
3. S.K. Bhattacharya, 'Electrical Machines' McGraw - Hill Education, New Delhi, 3$^{rd}$ Edition, 2009.
4. Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016

5. Surinder Pal Bali, 'Electrical Technology Machines & Measurements, Vol.II, Pearson, 2013
6. Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', Sixth edition, Tata McGraw Hill Books Company, 2003.
7. B.L.Theraja., "Electrical Technology" S.Chand publications Pvt. Ltd., New Delhi, 2011.

Course Code& Name: **EE8301 ELECTRICAL MACHINES I**
Degree/Programme: **B.E/EEE** Semester: **III** Section: **A, B**
Duration: **JUNE 2018 – DEC 2018** Regulation: **2017/AUC**
Name of the Staff:

**AIM:** To model and analyze electrical apparatus and their application to power system

## OBJECTIVES:

To impart knowledge on the following Topics

- Magnetic-circuit analysis and introduce magnetic materials
- Constructional details, the principle of operation, prediction of performance, the methods of testing the transformers and three phase transformer connections..
- Working principles of electrical machines using the concepts of electromechanical energy conversion principles and derive expressions for generated voltage and torque developed in all Electrical Machines.
- Working principles of DC machines as Generator types, determination of their noload/ load characteristics, starting and methods of speed control of motors.
- Various losses taking place in D.C. Motor and to study the different testing methods to arrive at their performance.

**COURSE OUTCOMES:**

| C | Course Outcomes |
|---|---|
| C2 10.1 | Understand the techniques of magnetic-circuit analysis and introduce magnetic materials |
| C2 10.2 | Understand the constructional details, the principle of operation, prediction of performance, the methods of testing the transformers and three phase transformer connections |
| C2 10.3 | Understand the working principles of electrical machines using the concepts of electromechanical energy conversion principle and derive expressions for generated voltage and torque developed in all |
| C2 10.4 | Understand the working principles of dc machines as generator determination of their no load /load characteristics. |
| C2 10.5 | Understand the working principles of dc motor types, characteristics, braking and testing. |

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

| Course | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C2 10.1 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 3 | - | 2 |
| C2 10.2 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 3 | - | 1 |
| C2 10.3 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | - | 2 | 3 | 1 | 2 |
| C2 10.4 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 3 | 2 | 2 |
| C2 10.5 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | 2 | - | 3 | 2 | 2 |

**UNIT – I MAGNETIC CIRCUITS AND MAGNETIC MATERIALS Target Periods: 9**

| Sl N o | Contents | CO Statement | Book Reference & Page No | Delivery method | Delivery Periods | Knowledge Level |
|---|---|---|---|---|---|---|
| 1 | Magnetic circuits | C2 10.1 | TB1:11-12 | Chalk & board / PPT | **1** | R & U |
| 2 | Laws governing magnetic circuits | C2 10.1 | TB1:31 | Chalk & board / PPT | **1** | R & U |
| 3 | Flux linkage, Inductance and energy | C2 10.1 | TB1:30-30 | Chalk & board / PPT | **1** | R, U, An |
| 4 | Statically and Dynamically induced EMF | C2 10.1 | TB1:32 | Chalk & board / PPT | **2** | R, U, An |
| 5 | Torque | C2 10.1 | TB1:32 | Chalk & board / PPT | **1** | R, U, An |
| 6 | Hysteresis and Eddy Current losses | C2 10.1 | TB2:36-37 | Chalk & board / PPT | **2** | R,U, A |
| 7 | AC excitation, introduction to permanent magnets | C2 10.1 | TB: 39-40 | Chalk & board / PPT | **2** | An, E |
| 8 | Transformer as a magnetically Coupled circuit | C2 10.1 | TB2:42 | Chalk & board / PPT | **2** | R, U, An |

**UNIT II TRANSFORMERS Target Periods:9**

| Sl No | Contents | CO Statement | Book Reference & Page No | Delivery method | Delivery Hrs | Knowledge Level |
|---|---|---|---|---|---|---|
| 1 | Construction | C2 10.2 | TB1:53 | Chalk & board / PPT | **1** | R, A, An |
| 2 | Principle of operation | C2 10.2 | TB1:60-62 | Chalk & board / PPT | **1** | R, U, A, An |
| 3 | Equivalent circuit parameters | C2 10.2 | TB1:68-73 | Chalk & board / PPT | **1** | R, U, A, An |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | Phasor diagrams | C2 10.2 | TB1:76-77 | Chalk & board / PPT | **1** | R, U, A, An |
| 5 | Losses | C2 10.2 | TB1:79 | Chalk & board / PPT | **1** | R, U, A, An |
| 6 | Testing | C2 10.2 | TB1: 79-86 | Chalk & board / PPT | **2** | R, A, An |
| 7 | Efficiency and voltage regulation-all day efficiency-Sumpner's test, per unit representation | C2 10.2 | TB1:91-101 | Chalk & board / PPT | **1** | A, An, E |
| 8 | Inrush current | C2 10.2 | TB1:102-104 | Chalk & board / PPT | **1** | R, U, A, An |
| 9 | Three phase transformers-connections – Scott Connection – Phasing of transformer–parallel operation of three phase transformers | C2 10.2 | TB1:111-116 | Chalk & board / PPT | **1** | R, A, An |
| 10 | Auto transformer – tap changing transformers | C2 10.2 | TB1:104, 140 | Chalk & board / PPT | **1** | A, An, E |
| 11 | Tertiary winding | C2 10.2 | TB1:133 | Chalk & board / PPT | **1** | R, U |

**UNIT III** **ELECTROMECHANICAL ENERGY CONVERSION AND CONCEPTS IN ROTATING MACHINES** **Target Periods: 9**

| Sl No | Contents | CO Statement | Book Reference & Page No | Delivery method | Delivery Hrs | Knowledge Level |
|---|---|---|---|---|---|---|
| 1 | Energy in magnetic system | C2 10.3 | RB1:157-159 | Chalk & board / PPT | **1** | R, U, An |
| 2 | Field energy and coenergy-force and torque equations | C2 10.3 | RB1:161-162 | Chalk & board / PPT | **2** | R, U, A, An |
| 3 | singly and excited magnetic field systems | C2 10.3 | RB1:161-165 | Chalk & board / PPT | **2** | R, U, A, An |
| 4 | Mmf of distributed windings | C2 10.3 | RB1:225-232 | Chalk & board / PPT | **1** | R, A, |
| 5 | Winding Inductances | C2 10.3 | RB1:259-263 | Chalk & board / PPT | **1** | R, U, A, |
| 6 | Magnetic fields in rotating machines | C2 10.3 | RB1:233-235 | Chalk & board / PPT | **2** | R, U, A, An |
| 7 | rotating mmf waves | C2 10.3 | RB1:233-235 | Chalk & board / PPT | **2** | R, U, A, An |

| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | Magnetic saturation and leakage fluxes. | C2 10.3 | RB1:15-16 | Chalk & board / PPT | **1** | R, U, An |

**UNIT IV** **DC GENERATORS** **Target Periods:9**

| Sl No | Contents | CO Statement | Book Reference & Page No | Delivery method | Delivery Hrs | Knowledge Level |
|---|---|---|---|---|---|---|
| 1 | Principle of operation | C2 10.4 | RB2:888-890 | Chalk & board / PPT | **1** | R, U |
| 2 | Construction and components of DC Machine | C2 10.4 | RB2:890-895 | Chalk & board / PPT | **2** | R, U, A, An |
| 3 | Lap and wave windings | C2 10.4 | RB2:896-910 | Chalk & board / PPT | **2** | R, U, A, An |
| 4 | Circuit model | C2 10.4 | RB2:911-914 | Chalk & board / PPT | **1** | R, U, A, An |
| 5 | EMF equations | C2 10.4 | RB2:914-924 | Chalk & board / PPT | **1** | R, U, A, An |
| 6 | Armature reaction | C2 10.4 | RB2:938-945 | Chalk & board / PPT | **1** | R, U, A, An |
| 7 | Methods of excitation | C2 10.4 | RB2:938-945 | Chalk & board / PPT | **1** | R, U, A, An |
| 8 | Commutation and interpoles | C2 10.4 | RB2:946-951 | Chalk & board / PPT | **1** | R, U, A, An |
| 9 | Compensating winding | C2 10.4 | RB2: 946-951 | Chalk & board / PPT | **1** | R, U, A, An |
| 10 | Characteristics of DC generators | C2 10.4 | RB2:968-978 | Chalk & board / | **1** | R, U, A, An |

**UNIT V** **DC MOTORS** **Target Periods: 9**

| Sl No | Contents | CO Statement | Book Reference & Page No | Delivery method | Delivery Hrs | Knowledge Level |
|---|---|---|---|---|---|---|
| 1 | Principle and operations | C2 10.5 | TB2:996-1014 | Chalk & board / PPT | **2** | R, U, A, An |
| 2 | Types of DC Motors | C2 10.5 | TB2:1015-1027 | Chalk & board / PPT | **1** | R, U, A, An |
| 3 | Speed Torque Characteristics of DC Motors | C2 10.5 | TB2:1031-1061 | Chalk & board / PPT | **2** | R, U, A, An |
| 4 | Starting and speed control of DC motors | C2 10.5 | TB2:1061-1031 | Chalk & board / PPT | **1** | R, U, A, An |
| 5 | Plugging, dynamic and regenerative braking | C2 10.5 | TB2:1062-1073 | Chalk & board / PPT | **1** | R, U, A, An |
| 6 | Testing and efficiency | C2 10.5 | TB2:1092-1111 | Chalk & board / PPT | **1** | R, U, A, An |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | Retardation test | C2 10.5 | TB2:1092-1111 | Chalk & board / PPT | **1** | R, U, A, An |
| 8 | Swinburne's test and Hopkinson's test | C2 10.5 | TB2:1092-1111 | Chalk & board / PPT | **1** | R, U, A, An |
| 9 | Permanent magnet dc motors(PMDC) | C2 10.5 | TB2:1547-1549 | Chalk & board / PPT | **1** | R, U, A, An |
| 10 | DC Motor applications | C2 10.5 | TB2:1021 | Chalk & board / PPT | **1** | R, U, A, An |

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

**Books:Text/Reference:**

| S.No | | Title of the Book | Author | Publisher | Year |
|---|---|---|---|---|---|
| 1 | **TB1** | Electric Machines | Nagrath I. J and Kothari D. P. | Tata McGraw Hill Publishing Company Ltd, Fourth Edition | 2010 |
| 2 | **RB1** | Electric Technology | B.L.Theraja | S.Chand publications Pvt. Ltd., New Delhi | 2011 |

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|---|---|
| **Comments Given by the Scrutinizing Committee Members** | |
| **Signature of the Scrutinizing** | |
| **Signature of the HOD** | |

# EE6401 ELECTRICAL MACHINES – I
## UNIT –I
## MAGNETIC CIRCUITS AND MAGNETIC MATERIALS

## PART: A

1. **Explain statically induced EMF ?April/May 2015**

   Self-Induced EMF is that EMF which is induced in the conductor by changing in its own. When current is changing the magnetic field is also changing around the coil and hence Faraday's law is applied here and EMF are induced in the coil to its self which called self-induced EMF.

2. **State Ampere's Law. May/June 2016**

   Ampere's Law states that for any closed loop path, the sum of the length elements times the magnetic field in the direction of the length element is equal to the permeability times the electric current enclosed in the loop.

3. **Prepare the list of the materials suitable for fabrication of Permanent Magnets. April/May 2015**

   Alnico alloy, Stontinum, neodymium and iron boron

4. **What are quasi-static? May/June 2014**

   All the electromechanical energy conversion devices are slow because of the inertia associated with the moving parts. Thereforth field in the device is also slow in nature i.e Quasistatic field. And there is no time lag between exciting current and the establishment of magnetic flux

5. **Define Magnetic reluctance**. **May/June 2014**

   The opposition that the magnetic circuit offers to flux is called reluctance. It is expressed as the ratio of MMF to flux. It is denoted by S and its unit is AT/m

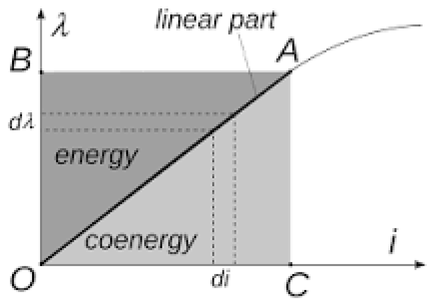
6. **Define Flux linkage. Nov/Dec 2013**

   A magnetic field going through a coil of wire has a property *known as flux linkage*. This is the product of the flux Φ and the number of coils in the wire N.

7. **Define energy and Co-energy in electromechanical syste**m. **Nov/Dec 2013Nov/Dec 2009**

   The concept of *co-energy* can be applied to many conservative systems (inertial mechanical, electromagnetic, etc.), which can be described by a linear relationship between the input and stored *energy*. To calculate the attractive magnetic force acting on the movable part we will introduce the quantity called **co-energy**. It is defined as

$$W_f' = \int_0^{i_1} \lambda \cdot di$$

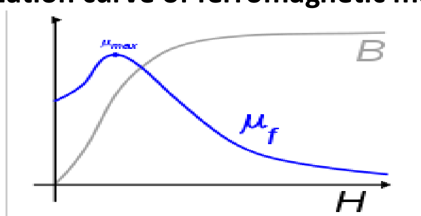



$$Energy = area\ OABO = W_{stored} = \int_0^{\lambda} i(\lambda)\, d\lambda$$

$$Coenergy = area\ OACO = W'_{stored} = \int_0^{i} \lambda(i)\, di$$

$$Energy(W) + Coenergy(W') = i\lambda$$

8. **Classify the basic type so for rating electric machines? May/June 2013 April/May 2011**
   1.DC machines
   2.AC machines
   3.Special machines
9. **Draw and explain the magnetization curve of ferromagnetic material. May/June 2013**




Due to saturation, the magnetic permeability $\mu_f$ of a ferromagnetic substance reaches a maximum and then declines

10. **Define EMF and MMF. May/June 2012**

| Name | Symbol | Units | | Name | Symbol | Units |
|---|---|---|---|---|---|---|
| Magnetomotive force (MMF) | $\mathcal{F} = \int \mathbf{H} \cdot \mathrm{d}\mathbf{l}$ | ampere-turn | | Electromotive force (EMF) | $\mathcal{E} = \int \mathbf{E} \cdot \mathrm{d}\mathbf{l}$ | volt |

Electromotive force (EMF) drives a current of electrical charge in electrical circuits, magneto motive force (MMF) 'drives' magnetic flux through magnetic circuits. MMF is the cause for producing flux in a magnetic circuit. the amount of flux setup in the core decent upon current(I) and number of turns(N). The product of NI is called MMF and it determine the amount of flux setup in the magnetic circuit MMF=NI ampere turns (AT)

11. **What are the core losses and how can this loss be minimized? Justify. May/June 2012**

When a magnetic material undergoes cyclic magnetization, two kinds of power losses occur on it. Hysteresis and eddy current losses are called as core loss. It is important in determining heating, temperature rise, rating & efficiency of transformers, machines &other A.C run magnetic devices.

Hysteresis losses can be reduced by selecting suitable core having small area of B-H loop curve and eddy current losses can be reduced by laminating the core.

12. **Distinguish statically and dynamically induced EMF**. **Nov/Dec 2011 Nov Dec 2010**

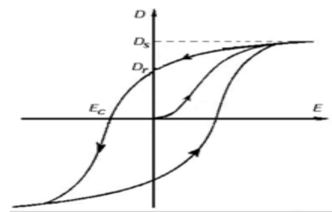
**Static EMF**

The emf induced in a stationary conductor due to alternating magnetic field is statically induced emf.

**Dynamic EMF**

The emf induced in the moving conductor due to stationary flux is called dynamically induced EMF.

13. **What is the Hysteresis loss and how can this loss be minimized? Nov/Dec 2011.**




Electric displacement field $D$ of a ferroelectric material as the electric field $E$ is first decreased, then increased. The curves form a *hysteresis loop*.

**Hysteresis loss**

The magnetic field intensity [H] is increased from zero to maximum and the energy is stored Now again the H is reduced to zero, dB is negative ,the energy is given out by the magnetic field .The net energy lost due this in the form of heat and is called as hysteresis loss.

Eddy Current loss : When a magnetic core carries time –varying flux,voltages are induced in all possible paths enclosing the flux.The result is the production of circulating current in the core.These currents are known as eddy-current and have power loss i2R associated with them called Eddy-Current loss.

14. **A conductor 80cm long moves at right angle to its length at a constant speed of 30 m/s in a uniform magnetic field of flux density 1.2 T. Find the emf induced when the conductor motion is normal to the field flux**.**April/May 2011**

Gn: B= 1.2 T L=0.8m V= 30m/s ,e= BLV Sinθ

e= 1.2*0.8*30*sin90 , e=28.8V

15. **Give the analogy between electric circuit and magnetic circuit**.**Nov/Dec 2010**

| **S.No** | **Electric field** | **Magnetic field** |
|---|---|---|
| 1 | EMF | MMF |
| 2 | Current | Flux |

| | | |
|---|---|---|
| 3 | Resistance | Reluctance |
| 4 | Resistivity | Permeability |

16. **Define Torque . April/May 2010**
    The torque/ moment or moment of force (see the terminology below) is the tendency of a force to rotate an object around an axis
17. **How is emf induced dynamically? April/May 2010**
    The emf induced in the moving conductor due to stationary flux is called dynamically induced EMF.
18. **State Lenz's law. Nov/Dec 2009**
    The law states that the induced emf always opposes the very cause producing it.
19. **What is retentivity?**
    The property of magnetic material by which it can retain the magnetism even after the removal of inducing source is called retentivity.
20. **Define permeance?**
    It is the **reciprocal of reluctance** and is a measure of the cause the ease with which flux can pass through the material its unit is wb/AT
21. **Define magnetic flux intensity?**
    It is defined as the mmf per unit length of the magnetic flux path. it is denoted as H andits unit is AT/m . H=NI/L
22. **Define permeability?**
    It is the ability to conduct the magnetic flux. The Greater the permeability of material, the greater its conductivity for magnetic flux and vice versa.
23. **Define relative permeability?**
    It is equal to the ratio of flux density produced in that material to the flux density produced in air by the same magnetizing force
    $\mu_r=\mu/\mu_0$
24. **What is leakage coefficient?**
    Leakage coefficient=total flux/useful flux
25. **State faradays law of electromagnetic induction**
    Whenever a flux linking with the coil changes, emf is induced in the coil. The magnitude of induced emf is proportional to rate of change flux linkage $e = Nd\Phi/dt$
26. **Define self inductance?** Nov/Dec 17
    The property of a coil that opposes any change in current flowing through it is called self inductance
27. **Define mutual inductance?**
    The change in flux in a coil leads to induced emf in the another coil in the coupled circuits. This phenomenon is called mutual inductance.
28. **Define coefficient coupling?**
    The amount of coupling between two inductively coupled coils is expressed as co efficient of coupling. $K=M/\sqrt{[L_1L_2]}$
29. **What is fringing effect?**

It is seen that the useful flux passing across the air gap tends to buldge outwords, there by increasing the effective area of the air gap and reducing the flux density in the gap is called fringing effect.

**30. . What is mean by stacking factor?**

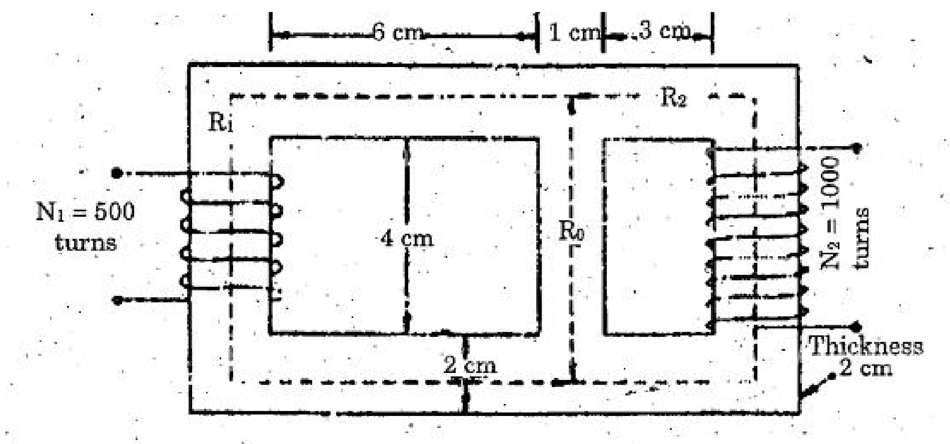
Magnetic cores are made up of thin, lightly insulated laminations to reduce the eddy current loss. As a result, the net cross sectional area of the core occupied by the magnetic material is less than its gross cross section; their ratio being is called the stacking factor. The stacking value is normally less than one .its value vary from 0.5 to 0.95.

**31. State leakage flux MAY/JUNE 16**

The flux going away from the intended path and not useful [lost in air] in anyway. This Stray flux is called as leakage flux

## PART:B

1. For the magnetic circuit as shown below, Calculate the self and mutual inductance Between the two coils. Assume core permeability=1600 (16)
(T-1 PG-33)**MAY/JUNE 14**




2. Explain the methods of energy conversion via Electric Field, with examples of Electrical Machines.
(16)---(T1 –P166) **APRIL/MAY 15**

***3.*** Explain Hysteresis and Eddy current losses in Electrical machines along with the causes.
[T1-P36]

(i)Also give the methods in construction to minimize the above losses.(8)
(T-1 PG: 37) ***MAY /JUNE 16*** **, APRIL/MAY 15, NOV/DEC 13,APRIL/MAY 2011**

(ii)List the properties of magnetic material suitable for fabrication Permanent Magnet and Electromagnet. (8)---(T-1 PG-27) ***MAY /JUNE 16*** **APRIL/MAY 15**

4. (i)Describe the AC operation of magnetic circuits. (8)---(T-1 PG-34) **MAY/JUNE 14**

(ii)Describe the principle of a typical magnetic circuit with explain. Also show that the core reluctance may be neglected in practice. (8)---(T-1 PG-11) **MAY/JUNE 14**

5. The magnetic circuit :$A_C$=4*4cm2 $I_g$=0.06cm,$I_C$=40cmandN=600 turns. Assume the value of $\mu_r$=6000 for iron.Measure the exciting current for $B_C$=1.2T and the corresponding flux and flux linkages. (16)(T-1 PG-18)**MAY/JUNE 14**

6. A single phase 50Hz,100 KVA transformer for 12000/240V ratio has a maximum flux density of 1.2Wb/$m^2$and an effective core section of 300$cm^2$ the magnetizing current is 0.2A.Identify the inductance of each wire on open circuit(16) **MAY/JUNE 12**

7. (i)Derive the expression for self and mutual inductance of the coil.(8)(T-1 PG-30)
(ii) Two coils A and B are wound on same iron core. There are 600 turns on A and 3600 turns on B. The current of 4A through coil. A produces a flux of 500* $10^{-6}$ Wb in the core. If this current is reversed in 0.02sec.Identify the average emf induced in coils A and B.(8)

8. (i)Explain the losses in magnetic materials(8)---(T-1 PG-36)
(ii)The field winding of the electromagnets is wound with 800turns and has a resistance of 40Ω when exciting voltage is 230V, magnetic flux around the coil is 0.004.Calculate self-inductance and energy in magnetic field.(8)

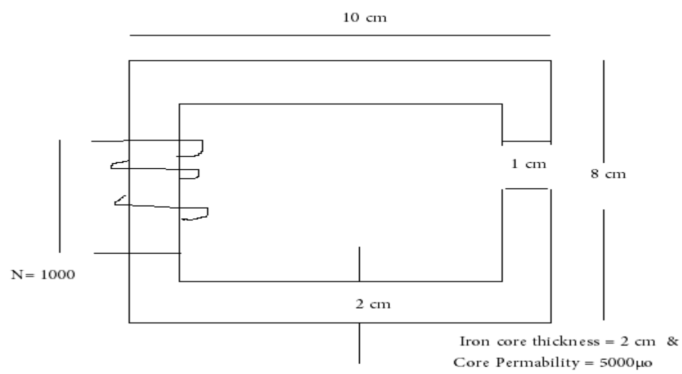
9. (i)Give the expression for energy density in the magnetic field.(4) (T-1 PG 35)
(ii)Describe Statically Induced EMF and Dynamically Induced EMF **MAY/JUNE 12**
(iii)The total core loss of a specimen of silicon steel is found to be 1500Watt 50Hz. Keeping the flux density constant the loss becomes 3000W when the frequency is raised to 75Hz.Calculate separately the hysteresis and eddy current loss at each of their frequencies.
(8)---(T-1 PG-38-39) **APRIL/MAY 2011**

**10.** Compare the similarities and dissimilarities between electric and magnetic circuits.(16)
**NOV/DEC 2011 APRIL/MAY 2011**

11. (i)Define Inductance of a coil.
(ii) Define permeability of a magnetic material and the factors on which it depends.
(iii) Explain the operation of AC magnetic cirvuit when AC current is applied to the coil wound on iron core .Draw the B-H curve and obtain an expression for Hysteresis loss.
**NOV/DEC 2009**

**12.** A ring composed of three sections .The cross section is 0.001m2 for each section .the mean arc length are La = 0.3m, Lb = 0.2m, Lc = 0.3m, an air gap length of 0.1 mm is cut in the ring ,µr for the sections a,b, and c are 5000,1000 and 10000 respectively .Flux in the air gap is 7.5 x 10-4 Wb.Find (i) mmf (ii)Exciting current if the coil has 100 turns (iii) Reluctance of the sections **NOV/DEC 2011**

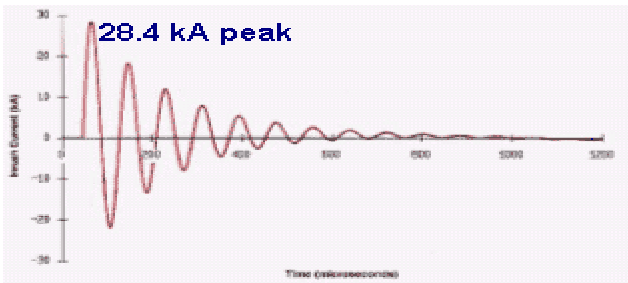
**13.** For the magnetic circuit shown in fig determine the current requires to establish a flux density of 0.5 T in the air gap. **NOV/DEC 2010**


10 cm
1 cm
8 cm
N= 1000
2 cm
Iron core thickness = 2 cm &
Core Permability = 5000μo

## UNIT–II: TRANSFORMERS

## PART:A

1. **Define all day efficiency of a transformer? MAY/JUNE 16**
   It is computed on the basis of energy consumed during a certain period, usually a day of 24 hrs. All day efficiency=output in kWh/input in kWh for 24 hrs
2. **What is inrush current of transformer? MAY/JUNE 16**
   The current drawn by the transformer during few cycles of supply voltage when it is energized called as inrush current. It is around 30 to 50 times of rated current.




3. **State the applications of Auto-Transformer. APRIL/MAY 15**
   - Used to get variable voltage from the fixed input.
   - Used as induction motor starter.
4. **Describe the role of tertiary winding in Transformer. APRIL/MAY 15 , MAY/JUNE 14**
   - It reduces the unbalancing in the primary due to unbalancing in three phase load.
   - It is required to supply an auxiliary load in different voltage level in addition to its main secondary load.
5. **Differentiate between a core and shell type transformer**. Nov/Dec 17, MAY/JUNE 14
   In core type, the windings surround the core considerably and in shell type the core surrounds the windings i.e winding is placed inside the core
6. **Define voltage regulation of a transformer? NOV/DEC 15**
   The change in secondary terminal voltage from no load to full load expressed as a percentage of no load or full load voltage is termed as regulation.
   %regulation $=E_2-V_2/E_2$ *100
   $V_2>E_2$ for leading p.f load , $V_2<E_2$ for lagging p.f load
7. **What is Ideal Transformer ? NOV/DEC 15**
   An ideal transformer has the following properties,
   - no copper losses (no winding resistance)
   - no iron loss in core.
   - no leakage flux
8. **What are the losses in a transformer? MAY/JUNE 2014**
   Copper loss, Core losses, dielectric losses and stray loss.

9. **List out any 4 three phase Transformer Connection MAY/JUNE 2014**
   Start /Delta
   Delta/Star

Scott Connection

Star /Star

10. **What happens if DC supply is applied to the transformer? MAY/JUNE 2012**
DC supply ( constant current) with frequency = 0, hence there won't be any induced emf which left the resistance alone to oppose the primary current. Thus its value is huge which in turn causes burning out of the winding.
11. **Explain why all day efficiency is lower than commercial efficiency? MAY/JUNE 2012**
The load on the transformer varies with time and thus the energy losses.
12. **Why is transformer rated in KVA? Just**ify. **NOV/DEC 11**
. Copper loss of a transformer depends on current & iron loss on voltage. Hence total losses depend on Volt-Ampere and not on PF. That is why the rating of transformers is in kVA and not in kW.
13. **Compare two winding Transformer & Auto-Transfomer**. **NOV/DEC 11**

| **S.No** | **Transformer** | **Auto-Transfomer** |
|---|---|---|
| 1 | Has two windings | One winding |
| 2 | Fixed output voltage | Variable voltage |
| 3 | There is an Electrical isolation between windings | No isolation |

14. **Which equivalent circuit parameters can be determined by the OC test of Transformer.APRIL/MAY 11**
Core Losses Parameters [Ro, Xo, Xm, Io and Wo]
15. **The emf per turn for a single-phase 2200/220V, 50Hz transformer is 11V. The number of primary and secondary turns. APRIL/MAY 11**
$E_t=E_1/N_1$ or $E_2/N_2$
$N_1=200$; $N_2=20$; [$E_t=11$; $E_1=2200$; $E_2=220$]
16. **Show the condition for parallel operation of a transformer? NOV/DEC 9**
    - Same voltage ratio of transformer.
    - Same percentage impedance.
    - Same polarity.
    - Same phase sequence
17. **Define principle of transformer? APRIL/MAY 2010**
A transformer is a static device which transfers power from one circuit to another circuit without changing the frequency by mutual induction principle.

18. **Draw the phasor diagram of transformer on No-Load?NOV/DEC 9**
**[BLT – P1126]**
19. **What is the purpose of laminating the core in a transformer?**
In order to minimise eddy current loss.
20. **Give the emf equation of a transformer and define each term?**
Emf induced in primary coil $E_1= 4.44f\Phi_m N_1$ volt

Emf induced in secondary Coil E2 =4.44 $f\Phi_m N_2$.
f--freq of AC input
$\Phi_m$-maximum value of flux in the core
$N_1$, $N_2$-Number of primary & secondary turns.

**21. Does transformer draw any current when secondary is open? Why?**

Yes, it (primary) will draw the current from the main supply in order to magnetize the core and to supply for iron and copper losses on no load. There will not be any current in the secondary since secondary is open.

**22. What determines the thickness of the lamination or stampings?**

- Frequency
- Iron loss

**23. What are the applications of step-up & step-down transformer?**

Step-up transformers are used in generating stations. Normally the generated voltage will be either 11kV. This voltage (11kV) is stepped up to 110kV or 220kV or 400kV and transmitted through transmission lines (simply called as sending end voltage).

Step-down transformers are used in receiving stations. The voltage are stepped down to11kV or 22kV are stepped down to 3phase 400V by means of a distribution transformerand made available at consumer premises. The transformers used at generating stationsare called power transformers.

**24. How transformers are classified according to their construction?**

1. Core type 2.shell type. In core type, the winding (primary and secondary) surround the core and in shell type, the core surround the winding.

**25. Explain on the material used for core construction?**

The core is constructed by **sheet steel** laminations assembled to provide a continuous magnetic path with minimum of air gap included. The steel used is of **high silicon** content sometimes heat treated to produce a high permeability and a low hysteresis loss at the usual operating flux densities. The eddy current loss is minimized by laminating the core, the laminations being used from each other by light coat of core plate vanish or by oxide layer on the surface. The thickness of lamination varies from 0.35mm for a frequency of 50Hz and 0.5mm for a frequency of 25Hz.

**26. How does change in frequency affect the operation of a given transformer?**

With a change in frequency, iron and copper loss, regulation, efficiency & heating varies so the operation of transformer is highly affected.

**27. What is the angle by which no-load current will lag the ideal applied voltage?**

In an ideal transformer, there are no copper & core loss i.e. loss free core. The no load current is only magnetizing current therefore the no load current lags behind by angle 90. However the winding possess resistance and leakage reactance and therefore the no load current lags the applied voltage slightly less than 90 .

**28. List the advantages of stepped core arrangement in a transformer?**

- To reduce the space effectively
- To obtain reduced length of mean turn of the winding
- To reduce I R loss.

**29. Why are breathers used in transformers?**

Breathers are used to entrap the atmospheric moisture and thereby not allowing it to pass on to the transformer oil. Also to permit the **oil inside the tank to expand and contract** as its temperature increases and decreases.

**30. What is the function of transformer oil in a transformer?**

- It provides good insulation
- Cooling

**31. Can the voltage regulation goes –ive? If so under what condition?**

Yes, if the load has leading PF.

**32. Distinguish power transformers & distribution transformers?**

Power transformers have very high rating in the order of MVA. They are used in generating and receiving stations. Sophisticated controls are required. Voltage ranges will be very high. Distribution transformers are used in receiving side. Voltage levels will be medium. Power ranging will be small in order of kVA. Complicated controls are not needed.

**33. Name the factors on which hysteresis loss depends?**

1. Frequency 2. Volume of the core 3. Maximum flux density

**34. Why the open circuit test on a transformer is conducted at rated voltage?**

The open circuit on a transformer is conducted at a rated voltage because **core loss depends upon the voltage**. This open circuit test gives only core loss or iron loss of the transformer.

**35. What is the purpose of providing Taps in transformer and where these are provided?**

In order to get different voltage levels at secondary, tapings are provided,

**36. What are the necessary tests to determine the equivalent circuit of the transformer?**

1. Open circuit test
2. Short circuit test

**37. Define efficiency of the transformer?**

Transformer efficiency ή= (output power/input power) x 100

**38. Full load copper loss in a transformer is 1600W. What will be the loss at half load?**

If n is the ratio of actual load to full load then

copper loss = $n^2$ (F.L copper loss) -Pc = $(0.5)^2$ – 1600=400W

## PART:B

1. Draw a circuit and explain how to obtain equivalent circuit by conducting O.C & S.C test in a single phase Transformer. [T1-P81-82] **MAY/JUNE 16,12 APRIL/MAY 10**
2. Explain the various three phase transformer connection and parallel operation of three phase transformer. **MAY/JUNE 16**[T1-P132
3. What is meant by inrush current in Transformer? Specify the nature of Inrush currents and its problem during Transformer charging**.[T1-102] APRIL/MAY 15**
4. A 500KVATransformer has a core loss of 2200 watts and a full load copper loss of 7500 watts.If the power factor of the load is 0.90 lagging, Evaluate the full load efficiency and the KVA load at which maximum efficiency occurs. **APRIL/MAY 15**
5. Specify the conditions for parallel operation of Transformer .Also explain the effect of load sharing due to impedance variation between transformer during parallel operation**. APRIL/MAY 15 , NOV/DEC 13[** T-1 P-126]
6. A100 KVA,3300V/240V,50HZ single phase transformer has 990 turns on the primary. Identify the number of turns on secondary and the approximate value of primary and secondary full load currents. **APRIL/MAY 15**
7. (i)Explain the principle of operation of a transformer. Derive its emf equation.(8)[T-1 P-53 ] **MAY/JUNE 14**

(ii)A single phase transformer has 180turns respectively in it secondary and primary windings. The respective resistances are 0.233 and 0.067.Calculate the equivalent resistance of a)the primary in terms of the secondary winding b)the secondary interms of the primary winding c)the total resistance of the transformer interms of the primary(8) **MAY/JUNE 14**

8. Describe the phasor diagram of transformer when it is operating under load and explain.(8) **MAY/JUNE 14** [BLT P-1129]
9. The parameters of approximate equivalent circuit of a 4KVA,200/400V,50Hz single phase transformer are $R'_p$=0.15Ω;$X'_p$=0.37Ω;$R_o$=600Ω;$X_m$=300Ω when a rated voltage of 200V $i_a$ applied to the primary, a current of 10A at lagging power factor of 0.8 flows in the secondary winding. Identify
   (i)The current in the primary,$I_p$ (ii)The terminal voltage at the secondary side.(8)
   **MAY/JUNE 14**
10. Explain the construction and working of core type and shell type transformers with neat sketches.(16) [BLT- P-1118] **MAY/JUNE 13**
11. Explain the construction and principle of a working transformer . [T-1 P-61](8) **NOV/DEC13**
12. Develop the equivalent circuit of a single phase transformer Referred to primary and secondary.(16) [T1- P-60] **NOV/DEC13 APRIL/MAY 10**
13. Obtain the equivalent circuit of a 200/400V 50Hz single phase transformer from the following test data.
    O.C.test:200V,0.7W,70W –on L.VSide
    S.C.test:15V,10A,85W on H.Vside
    Calculate the secondary voltage when delivering 5kW at 0.8p.f.lagging.Theprimary voltagebeing200V. (16)
14. (i)Derive an expression for maximum efficiency of a transformer.(8)--- (T-1 P-79)
15. Derive an expression for the emf of an ideal transformer. **MAY/JUNE 12**
16. Calculate the efficiency at half,full load of a 100 KVA transformer for PF of unity and 0.8 .The copper loss is 1000 W at full load and iron loss is 1000 W. **MAY/JUNE 12**
17. Explain the causes of voltage drop in a power transformer on load and develop the equivalent circuit for a single phase transformer. **NOV/DEC 11**
18. A 3 phase step down transformer is connected to 6.6 KV mains and takes 10 Amps.Calculate the secondary line voltages and line current for the (i) Δ/Δ (ii) Ỵ/Ỵ (iii) Δ/ Ỵ (iv) Ỵ/Δ connection.The ratio of turns per phase is 12 and neglect no load losses.
    **MAY/JUNE 12**
19. Derive an expression for saving copper when an auto transformer is used.
    **MAY/JUNE 12, APRIL/MAY 10**
20. Obtain the equivalent circuit of a 2000/200V 50Hz single phase transformer referred to HV and LV sides respectively from the following test data.
    O.C.test:200V,4,120W –on L.VSide
    S.C.test:60V,10A,300W on H.Vside **APRIL/MAY 11**
21. A three transformer bank consisting of three single phase transformers is used to step down the voltages of a 3phase ,6600V transmission .If the primary line current is 10 A ,Calculate the secondary line voltages, line current and output KVA for the following connections:
    (1) Δ/ Ỵ (2) Ỵ/Δ ,Turns ratio is 12 .Neglect losses. **APRIL/MAY 11**

22. A 20 kVA ,2500/500 V,single –phase tensformer has the following parameters:
    HV WINDING: r1= 8 ohm and x1= 17 ohm
    LV WINDING : r2= 0.3 ohm and x2=0.7 ohm

Find the voltage regulation and the secondary terminal at full llad for a pf of 0.8 lagging and 0.8 leading.the primary voltages is held constant at 2500V .

**APRIL/MAY 11**

23. Define the voltage regulation of two winding transformer and explain its significance.

**NOV/DEC 10**

24. A 100 kVA ,6600 V / 330V,50 Hz single phase transformer took 10 A and 436W at 100V in a short in a short circuit test,the figure reffering to the high voltage side.Calculate the voltage to be applied to the high voltage side on full load at power factor 0.8 lagging when the secondary terminal voltage is 300 V. **NOV/DEC 10**
25. Explain various types of three phase transformer connections. **APRIL/MAY 10**
26. A transformer has its maximum efficiency of 0.98 at 15kVA at unity power factor. During the day it is loaded as follows:

    12 hour 2kW at power factor 0.6

    6 hour 12kW at power factor 0.8

    4 hour 18kW at power factor 0.9

    2 hour No load **NOV/DEC 10**
27. The voltage per turn of a single phase transformeris1.1volt,when the primary winding is connected to a 220volt,50Hz AC supply the secondary voltage is found to be 550volt. Identify the primary and secondary turns and core area if maximum flux density is 1.1Tesla.(16)
28. Describe the principle of operation of a transformer. Draw the vector diagram to represent a load at UPF,lagging and leading power factor.(16)

T-1 P-53 **APRIL/MAY 10**

29. Two 100KW transformer each has a maximum efficiency of 98% but in one the maximum efficiency occurs at full-load while in the other, it occurs at half-load. Each transformer is on full-load for 4 hours, on half-load for 6 hours and one-tenth load for 14 hours per day.Dertermine the all-day efficiency of each transformer. **NOV/DEC 09**
30. Derive an expression for Maximum efficiency of a transformer.[BLT-P1169]

**NOV/DEC 09**

31. Two 100kW ,single phase transformer are connected in parallel both on the primary and secondary .One transformer has an ohmic drop 0.5% at full load and an inductive drop of 8% at full load current.the other has an ohmic drop of 0.75% and inductive drop 0.75% and inductive drop of 2% Show how they will share a load of 180KW at 0.9 power .

**NOV/DEC 09**

32. Explain Sumpner's test.[T1-P86]
33. A 500KVAtransformer has 95% efficiency at full load and also at 60% of full load of that UPF. a)Separate out the transformer losses.b)Measure the transformer efficiency at 75% full load, UPF.(8)

# UNIT–III
# ELECTROMECHANICAL ENERGY CONVERSION AND CONCEPTS IN ROTATING MACHINES
## PART:A

1. **What is meant by winding Indutance.** MAY/JUNE 2016

   If a changing flux is linked with a coil of a conductor there would be an emf induced in it. The property of the coil of inducing emf due to the changing flux linked with it is known as **inductance of the coil**. Due to this property all electrical coil can be referred as **inductor**. In other way, an inductor can be defined as an energy storage device which stores energy in form of magnetic field.

2. **Write the equation which relates rotor speed in electrical and mechanical radian/second.** April/May 2015

   $\omega_e = \omega_m * (p/2)$

   $\omega_e$= rotor speed in electrical radians per sec

   $\omega_m$=speed in mechanical radians per sec

   p=no of poles

3. **Write the equation which relates electrical and mechanical angles of P pole machine.** Nov/Dec 2010

   $\Theta_e = \Theta_m * P/2$

   $\Theta_e$ – Electrical angle

   $\Theta_m$ – Mechanical angle

4. **Explain the concept of electrical degrees** nov/dec 2010

   It is calculated according to the no of poles of stator. Each pole contributes $180^0$ of electrical angle. If stator has 4 poles then the electrical angle will be $720^0$

5. **Give Examples of Multiple Excitation System**. MAY/JUNE 2013

   Single excited system-reluctance motor, single phase transformer, relay coil

   Multiply excited system-alternator, electro mechanical transducer

6. **Formulate the expression for torque in round rotor machine.**MAY/JUNE 2013

   $T = (-\pi/2) * (p/2)^2 \phi_r F_2 \sin\delta$

   T – Torque

   P – No of poles

   $\phi_r$ - Resultant flux per pole

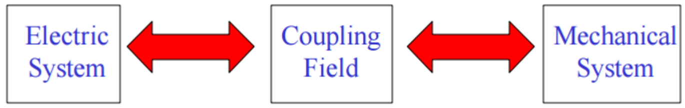
   $F_2$ – Rotor spatial mmf

7. **List the basic requirements of the excitation systems?** MAY/JUNE 2013

   The core, coil and supply are required to make an excitation system

8. **Block diagram of Electromechanical Energy conversion**. NOV/DEC 2011

## Electromechanical System in Simplified Form:




9. **State the principle of electromechanical energy conversion?** Nov/Dec 17,April/May 2011
   The mechanical energy is converted in to electrical energy which takes place through either by magnetic field or electric field
10. **What is the significance of co energy?** May/June 16,May/June 2012 & 2013
    When electrical energy is fed to coil not the whole energy is stored as magnetic energy the co energy gives a measure of other energy conversion which takes place in coil then magnetic energy storage [ie energy which is converted to other form]
11. **What does speed voltage mean?**
    It is that voltage generated in that coil, when there exists a relative motion between coil and magnetic field
12. **Why do all practical energy conversion devices make use of the magnetic field as a coupling medium rather than electric field?** May/June 2014
    When compared to electric field, energy can be easily stored and retrieved form a magnetic system with reduced losses comparatively. Hence most all practical energy conversion devices make use of magnetic medium as coupling
13. **State necessary condition for production of steady torque by the interaction of stator and rotor field in electric machines?**

- The stator and rotor fields should not have any relative velocity or speed between each other
- Air gap between stator and rotor should be minimum
- Reluctance of iron path should be negligible
- Mutual flux linkages should exist between stator and rotor windings

14. **Write the application of single and doubly fed magnetic systems?**
    Singly excited systems are employed for motion through a limited distance or rotation through a prescribed angle Whereas multiply excited systems are used where continues energy conversion take place and in ease of transducer where one coil when energized the care of setting up of flux and the other coil when energized produces a proportional signal either electrical or mechanical
15. **Define pole pitch**
    Pole pitch is that centre to centre distance between any two consecutive poles in a rotating machine, measured in slots per poles
16. **Define short charding angle**
    Chording angle is that angle by which the coil span is short of full pitched in electrical degrees
17. **Why energy stored in a magnetic material always occur in air gap**
    In iron core or steel core the saturation and aging effects form hindrance to storage Built in air gap as reluctance as well permeability is constant, the energy storage takes place linearly without any complexity Hence energy is stored in air gap in a magnetic medium

**18. Relate co energy density and magnetic flux density?**

Co energy density=$w_f$=∫λ (I, x) di

$w_f$=1/2BH

**19. . Short advantages of short pitched coil?**

- Harmonics are reduced in induced voltage
- Saving of copper
- End connections are shorter

**20. What is the significance of winding factor?**

Winding factor gives the net reduction in emf induced due to short pitched coil wounding distributed type

Winding factor kw=kp*kd
kp= pitch factor
kd= distribution factor
kp= cos(α/2)
kd= sin(mγ/2)/msin(γ/2)

**21. What is the necessity to determine the energy density in the design of rotating machines?**

Energy density $w_f=B^2/2\mu$

**22. Derive the relation between co energy and the phase angle between the rotor and stator fluxes of the rotating machines?**

F1, f2 are the rotor and stator flux peak values respectively
$F_{r2}=f_{12}+f_{22}+2f_1f_2\cos\alpha$
Co energy= $\{f_{12}+f_{22}+2f_1f_2\cos\alpha\}$

**23. Write the energy balance equation for motor?**

Mechanical energy o/p=electrical energy i/p-increase in field energy
$F_f\ dx=id\lambda-dW_f$

**24. What is magnetic circuit?**

The closed path followed by magnetic flux is called magnetic circuit

**25. Define magnetic flux?**

The magnetic lines of force produced by a magnet is called magnetic flux it is denoted as Φ and its unit is Weber

**26. Define magnetic flux density?** NOV/DEC 17

It is the flux per unit area at right angles to the flux it is denoted by B and unit is Weber/m2

**27. Define magneto motive force?**

MMF is the cause for producing flux in a magnetic circuit. the amount of flux setup in the core decent upon current(I)and number of turns(N).the product of NI is called MMFand it determine the amount of flux setup in the magnetic circuit MMF=NI ampere turns (AT)

28. **Give the materials used in machine manufacturing?**

There are three main materials used in m/c manufacturing they are steel to conduct magnetic flux copper to conduct electric current insulation.

**29. What are factors on which hysteresis loss?**

It depends on magnetic flux density, frequency & volume of the material.

**30. What is core loss? What is its significance in electric machines?**

When a magnetic material undergoes cyclic magnetization, two kinds of power losses occur on it. Hysteresis and eddy current losses are called as core loss. It is important in determining heating, temperature rise, rating & efficiency of transformers, machines & other A.C run magnetic devices.

**PART-B**

1. Explain the concept of singly excited machine and derive the expression for electromagnetic torque [or] Obtain the expression for energy in a attracted armature relay magnetic system May/June 2016 (T-1 P- 158)
2. Derive an expression for co energy in multiply excited magnetic field systems May/June 2016 & 2015 ( T-1 P-178)
3. Derive the torque equation of a round rotor machine clearly stating all the assumption made give the relation between field energy and the mechanical force developed in the field May/June 2015 ( T1 - P-241)
4. Explain the production of rotating magnetic field. What are the speed and direction of rotation of the field? Is the speed uniform? May/June 2014& Nov/Dec 2013 [T1-P233]
5. What is meant by current sheet concept? Explain briefly. What is the phase difference between a sinusoidally distributed current sheet and its accompanying mmf wave? May June 2014 [T1-P231]
6. A 4 pole lap wound DC machine has 728 armature conductors. Its field winding is excited from a DC source to create an air gap flux of 32 mwb/pole. The machine is from a prime mover at 1600 RPM. It supplies a current of 100A to an electric load
    a. Calculate the electromagnetic power developed
    b. What is the mechanical power that is fed from the prime mover to the generator
    c. What is the torque provided by the prime mover
7. Explain the mmf pattern of distributed winding of a machine. Nov/Dec 2013 [T1-P228]

# UNIT-4

## PART-A

1. **Compare lap winding and wave winding.** MAY/JUNE 2014& 16

| S.No | Lap Winding | Wave Winding |
|---|---|---|
| 1 | No of parallel path equal to no of poles [A=P] | Only two parallel paths |
| 2 | Used in a machine which are for low voltage high current | Used in a machine which are for high voltage low current |

2. **Specify the role of Inter poles in DC machines.** APRIL/MAY 15

   The inter poles are used in DC Machines to reduce the effect of armature reaction and self induction. The Inter poles are connected in series with armature winding so that as the armature current changes the flux due to inter poles chances accordingly.

3. **What is meant by residual emf in DC generator?** APRIL/MAY 15

   The flux presence in field winding even after removing the excitation is called residual flux. It helps for building the EMF to its rated value in the self excited generators.

4. **What is core loss? What is its significance in electric machines?**

   When a magnetic material undergoes cyclic magnetization, two kinds of power losses occur on it. Hysteresis and eddy current losses are called as core loss. It is important in determining heating, temperature rise, rating & efficiency of transformers, machines & other A.C run magnetic devices.

5. **Why a Synchronous machine does not produce torque at any other speed?** MAY/JUNE 14

   The stator and rotor mmfs are **loses its magnetic** locking except synchronous speed which is the basic requirement for torque production.

6. **Why the external characteristics of a DC shunt generator is more drooping than that of a separately excited generator?** MAY/JUNE 14

   The variation of armature voltage due to armature reaction and resistance drops affects the field flux which in turn affects the armature voltage. Hence the armature voltage is drooping nature. In the case of separately excited generators, the field supply is independent of armature voltage hence the effect will be less.

7. **Define Distribution factor.** NOV/DEC 2013

   As per definition, distribution factor, is measure of resultant emf of a distributed winding in compared to a concentrated winding. It is expressed as ratio of the phasor sum of the emfs induced in all the coils distributed in a number of slots under one pole to the arithmetic sum of the emfs induced.

8. **What is pitch factor?** NOV/DEC 2013

   The pitch or coil span factor is defined as the ratio of actual coil voltage to the coil voltage for a full-pitch coil. Hence, pitch factor, KP = Vector sum of induced emf per coil/ Arithmetic sum of induced emf per coil.

9. **Why fractional pitched winding is preferred over the full pitched winding?** May/June 2012
   - To reduce the harmonics
   - Saving of copper

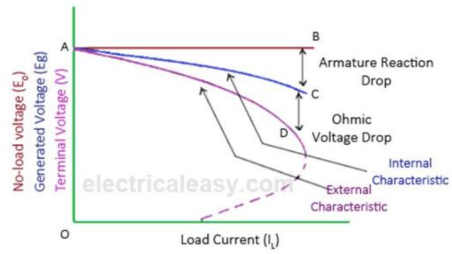
10. **Define winding factor.** Nov/Dec 2011

    $K_w=K_p*K_d$

$K_p$- Pitch factor

$K_d$- Distribution factor

**11. Draw the various characteristics of DC shunt generator.** MAY/JUNE 16




Characteristics of DC shunt generator

12. **Define Commutation.** MAY/JUNE 2012

The commutation in DC machine or more specifically commutation in DC generator is the process in which generated alternating current in the armature winding of a dc machine is converted into direct current after going through the commutator and the stationary brushes

13. **Write down the emf equation for d.c.generator?**

E= (ΦNZ/60) (P/A) Volt

p- no of poles

Z-Total no of conductor

Φ-flux per pole

N-speed in rpm.

14. **Why the armature core in d.c machines is constructed with laminated steel sheets instead of solid steel sheets?**

Lamination highly reduces the eddy current loss and steel sheets provide low reluctance path to magnetic field.

15. **Why commutator is employed in d.c.machines?**

Conduct electricity between rotating armature and fixed brushes, convert alternating emf into unidirectional emf (mechanical rectifier).

**16. Distinguish between shunt and series field coil construction?**

Shunt field coils are wound with wires of small section and have more no of turns. Series field coils are wound with wires of larger cross section and have less no of turns.

17. **How does D.C. motor differ from D.C. generator in construction?**

Generators are normally placed in closed room and accessed by skilled operators only. Therefore on ventilation point of view they may be constructed with large opening in the frame. Motors have to be installed right in the place of use which may have dust, dampness, inflammable gases, chemicals….etc. to protect the motors against these elements, the motor frames are made either partially closed or totally closed or flame proof.

18. **What is the function of no-voltage release coil in D.C. motor starter?**

As long as the supply voltage is on healthy condition the current through the NVR coil produce enough magnetic force of attraction and retain the starter handle in ON position against spring force. When the supply voltage fails or becomes lower than a prescribed value then electromagnet may not have enough force to retain so handle will come back to OFF position due to spring force automatically.

19. **Enumerate the factors on which speed of a d.c.motor depends?**

N= (V-IaRa)/Φ

so speed depends on air gap flux, resistance of armature, voltage applied to armature.

20. **Under What circumstances a dc shunt generator does fails to generate?**
**Absence of residual flux**, initial flux setup by field may be **opposite in direction** to residual flux, shunt field circuit resistance may be higher than its critical field resistance; load circuit resistance may be less than its critical load resistance.

21. **Define critical field resistance of dc shunt generator?**
Critical field resistance is defined as the resistance of the field circuit which will cause the shunt generator just to build up its emf at a specified field.

22. **Why is the emf not zero when the field current is reduced to zero in dc generator?**
Even after the field current is reduced to zero, the machine is left out with some flux as residue so emf is available due to residual flux.

23. **On what occasion dc generator may not have residual flux?**
The generator may be put for its operation after its construction, in previous operation; the generator would have been fully demagnetized.

24. **What are the conditions to be fulfilled by for a dc shunt generator to build back emf?**
The generator should have residual flux, the field winding should be connected in such a manner that the flux setup by field in same direction as residual flux, the field resistance should be less than critical field resistance, load circuit resistance should be above critical resistance.

25. **Define armature reaction in dc machines?** May/June 2013
The interaction between the main flux and armature flux cause disturbance called as armature reaction.

26. **What are two unwanted effects of armature reactions?**
Cross magnetizing effect & demagnetizing effect.

27. **What is the function of carbon brush used in dc generators?**
The function of the carbon brush is to collect current from commutator and supply to external load circuit and to load.

28. **Why an induction motor is called as rotating transformer?**
The rotor receives same electrical power in exactly the same way as the secondary of a two winding transformer receiving its power from primary. That is why induction motor is called as rotating transformer.

29. **Why an induction motor never runs at its synchronous speed?**
If it runs at synchronous speed then there would be no relative speed between the two, hence no rotor emf, so no rotor current, then no rotor torque to maintain rotation.

**30. What are slip rings?**
The slip rings are made of copper alloys and are fixed around the shaft insulating it. Through these slip rings and brushes rotor winding can be connected to external circuit.

**31. Why fractional pitched winding is preferred over full pitched winding?** MAY/JUNE 2013
Waveform of the emf can be approximately made to a sine wave and distorting harmonics can be reduced or totally eliminated. Conductor material, copper, is saved in the back and front end connections due to less coil-span. Fractional slot winding with fractional number of slots/phase can be used which in turn reduces the tooth ripples. Mechanical strength of the coil is increased.

32. **Name any 2 non-loading method of testing dc machines?**
    - Swinburne’s test
    - Hopkinson test

**33. Define armature reaction in dc machines?**

The interaction between the main flux and armature flux cause disturbance called as armature reaction.

34. **What are two unwanted effects of armature reactions?**
Cross magnetizing effect & demagnetizing effect.
35. **What is the function of carbon brush used in dc generators?**
The function of the carbon brush is to collect current from commutator and supply to external load circuit and to load.

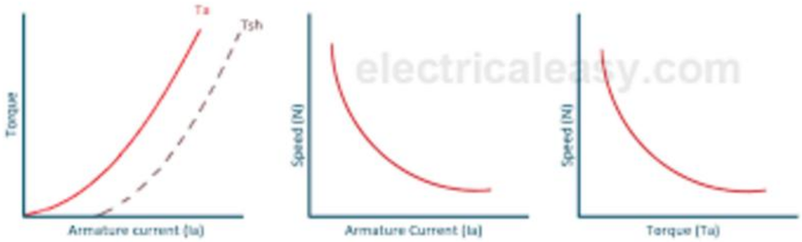
**PART-B**

1. Derive the emf equation of an DC generator (8) May/June 2016, April/may2015, NOV/DEC2011 (T-1 P-317)
2. Explain armature reaction of DC machines.(8) May/June 2016 (T-1 P-325)
3. Draw and explain the load characteristics of Differentially and Cumulatively compound DC generator.[8] April/may2015 (T-1 P-348)
4. Constructional features and operation of dc generator. [10] Nov/Dec2013 ( T-1 P-315)
5. Explain various Characteristics of DC Generator. [6] Nov/Dec2013, MAY/JUNE 2012,NOV/DEC 2010 (T-1 P-348)
6. Explain the working principles of different types of DC generators [16] May/June 2013 (BLT P -881 &911)
7. Explain commutation process in D.C. motor.[8] NOV/DEC 2013
8. Derive the torque equation of DC motor.[8] NOV/DEC 2013
9. A 4 pole DC motor is lap wound with 400 conductors. The pole shoe is 20cm long and the average flux density over the one pole pitch is 0.4T, the armature diameter being 30cm. find the torque and gross mechanical power developed when the motor is drawing 25A and running at 1500 RPM. [8] May/June 2016
10. A 4 pole DC shunt generator with lap connected armature supplies 5 KW at 230V. The armature and field copper losses are 360W and 200W respectively. Calculate the armature current and generated EMF? [10] May/June 2016
11. In a 400V DC compound generator, the resistance of the armature, series and shunt windings are 0.05Ω and 100 Ω respectively. The machine supplies power to 20 nos. resistive heaters, each rated 500W 400V. Calculate the induced emf and armature currents when the generator is connected in 1. Short shunt, 2. Long shunt. Allow brush contact drop of 2V per brush. [10] May/June 2016

**UNIT-5**

**PART- A**

1. **Draw the speed torque characteristics of DC series motor** MAY/JUNE 16




2. **What is meant by plugging?** MAY/JUNE 16
Type of braking is **Plugging type braking**. In this method the terminals of supply are reversed, as a result the generator torque also reverses which resists the normal rotation of the motor and as a result the speed decreases. During plugging external resistance is also introduced into the circuit to limit the flowing current. The main disadvantage of this method is that here power is wasted.
3. **Specify the techniques used to control the speed of DC shunt motor for below and above the rated speed?** APRIL/MAY 15
    - Flux control method
    - Voltage control method

4. **Why DC motor is suitable for traction applications?** APRIL/MAY 15
    - Because of High starting current and high starting torque
5. **What is armature reaction?** NOV/DEC 13
Armature reaction in a DC machine. In a DC machine, the main field is produced by field coils. In both the generating and motoring modes, the armature carries current and a magnetic field is established, which is called the armature flux. The effect ofarmature flux on the main field is called the armature reaction.
6. **How to control speed by armature control method in DC shunt motor?** NOV/DEC 13**.**
In the armature control method, the speed of the DC motor is directly proportional to the back emf (Eb) and Eb = V- IaRa. When supply voltage (V) and armature resistance Ra are kept constant, the Speed is directly proportional to armature current (Ia). If we add resistance in series with the armature, the armature current (Ia) decreases and hence speed decreases. This armature control method is based on the fact that by varying the voltage across the required voltage. The motor back EMF (Eb) and Speed of the motor can be changed. This method is done by inserting the variable resistance (Rc) in series with the armature.
7. **What are the applications of DC series motor?** NOV/DEC 13
Its high starting torque makes it particularly suitable for a wide range of traction applications. Industrial uses are hoists, cranes, trolly cars, conveyors, elevators, air compressors, vacuum cleaners, sewing machines etc.
8. **What is eddy current loss?**
When a magnetic core carries a time varying flux, voltages are induced in all possible path enclosing flux. Resulting is the production of circulating flux in core. These circulating current do no useful work are known as eddy current and have power loss known as eddy current loss.
9. **How hysteresis and eddy current losses are minimized?**

Hysteresis loss can be minimized by selecting materials for core such as silicon steel & steel alloys with low hysteresis co-efficient and electrical resistivity. Eddy current losses are minimized by laminating the core.

10. **How will you find the direction of emf using Fleming's right hand rule?**
The thumb, forefinger & middle finger of right hand are held so that these fingers are mutually perpendicular to each other, then forefinger gives the direction of the lines of flux, thumb gives the direction of the relative motion of conductor and middle finger gives the direction of the emf induced.

11. **How will you find the direction of force produced using Fleming's left hand rule?**
The thumb, forefinger & middle finger of left hand are held so that these fingers are mutually perpendicular to each other, then forefinger gives the direction of magnetic field, middle finger gives the direction of the current and thumb gives the direction of the force experienced by the conductor.

12. **What is the purpose of yoke in d.c machine?** Nov/Dec 17
    - It acts as a protecting cover for the whole machine and provides mechanical support for the poles.
    - It carries magnetic flux produced by the poles

13. **What are the types of armature winding?**
    - Lap winding, A=P,
    - Wave winding, A=2.

14. **How are armatures windings are classified based on placement of coil inside the armature slots?**
Single and double layer winding.

15. **Write down the emf equation for d.c.generator?**
E= (ΦNZ/60)(P/A)V.
p-no of poles
Z-Total no of conductor
Φ-flux per pole
N-speed in rpm.

16. **Why the armature core in d.c machines is constructed with laminated steel sheets instead of solid steel sheets?**
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17. **Why commutator is employed in d.c.machines?**
Conduct electricity between rotating armature and fixed brushes, convert alternating emf into unidirectional emf (mechanical rectifier).

18. **Distinguish between shunt and series field coil construction?**
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19. **How does d.c. motor differ from d.c. generator in construction?**
Generators are normally placed in closed room and accessed by skilled operators only. Therefore on ventilation point of view they may be constructed with large opening in the frame. Motors have to be installed right in the place of use which may have dust, dampness, inflammable gases, chemical etc. to protect the motors against these elements the motor frames are used partially closed or totally closed or flame proof.

20. **How will you change the direction of rotation of d.c.motor?**
Either the field direction or direction of current through armature conductor is reversed.
21. **What is back emf in d.c. motor? NOV/DEC 11**
As the motor armature rotates, the system of conductor come across alternate north and South Pole magnetic fields causing an emf induced in the conductors. The direction of the emf induced in the conductor is in opposite to current. As this emf always opposes the flow of current in motor operation it is called as back emf.
22. **What is the function of no-voltage release coil in d.c. motor starter?**
As long as the supply voltage is on healthy condition the current through the NVR coil produce enough magnetic force of attraction and retain the starter handle in ON position against spring force. When the supply voltage fails or becomes lower than a prescribed value then electromagnet may not have enough force to retain so handle will come back to OFF position due to spring force automatically.
23. **Enumerate the factors on which speed of a d.c.motor depends**?
$N= (V-IaRa)/\Phi$ so speed depends on voltage applied to armature, flux per pole, resistance of armature.
24. **Under what circumstances does a dc shunt generator fails to generate?**
Absence of residual flux, initial flux setup by field may be opposite in direction to residual flux, shunt field circuit resistance may be higher than its critical field resistance, load circuit resistance may be less than its critical load resistance.
25. **Define critical field resistance of dc shunt generator?**
Critical field resistance is defined as the resistance of the field circuit which will cause the shunt generator just to build up its emf at a specified field.
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30. **What are two unwanted effects of armature reactions?**
Cross magnetizing effect & demagnetizing effect.
31. **What is the function of carbon brush used in dc generators?**
The function of the carbon brush is to collect current from commutator and supply to external load circuit and to load.
32. **What is the principle of generator?**
When the armature conductor cuts the magnetic flux emf is induced in the conductor.
33. **What is the principle of motor?**
When a current carrying conductor is placed in a magnetic field it experiences a force tending to move it.

**PART-B**

1. Explain the method used to obtain efficiency at full load by conducting Hopkinson's Test. [16] BLT-1099] May/June 2016
2. The no load test of a 44.76 KW, 220V, D.C shunt motor gave the following figures; input current=13.25A, Field current=2.55A, resistance of the armature at $75^0$C=0.032Ω, and brush drop=2V. Estimate the full load current and efficiency [16] May/June 2016
3. Derive the torque equation of a DC motor from first principle. And explain the characteristics of DC shunt motor (12) (T-1 P-358) May/June 2014
4. What are the merits and demerits of hopkinson's test [4] [BLT-1101] May/June 2014
5. Explain how to obtain efficiency of DC motor by hopkinson's test [10] [BLT-1099] May/June 2014
6. Discuss in detail about shunt armature speed control of DC shunt motor [8] May/June 2014 [BLT-1041]
7. A 500V DC shunt motor running at 700 RPM takes an armature current of 50A. Its effective resistance is 0.4Ω. what resistance must be placed in series with armature to reduce the speed to 600RPM, the torque remaining constant? [8] May/June 2014
8. Explain the starting of DC motor using three point starter [8] [BLT-1074] Nov/Dec 2013
9. Describe how to obtain breaking in D.C. Shunt motor. [8] [BLT-1064] Nov/Dec 2013
10. Discuss in detail about field control method speed control of DC shunt motor and state its applications [8] Nov/Dec 2013 [BLT-1032]
11. With schematic diagrams, explain the working principle of different types of DC generator based on its excitation. [16] [BLT-890] May/June 2013.
12. Explain different methods of speed control of DC shunt motor with neat circuit diagrams [16] [BLT-1041] May/June 2013

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

# Question Paper Code : 50481

B.E./B.Tech./B.Arch. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017
Fourth Semester
Electrical and Electronics Engineering
EE 6401 – ELECTRICAL MACHINES – I
(Regulations 2013)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. Define Magnetic flux density.

2. Define Self Inductance.

3. List out the merits and demerits of core and shell type transformer.

4. How do you reduce leakage flux in a transformer ?

5. State the principle of electromechanical energy conversion.

6. Predominant energy storage occurs in the air gap of an electromechanical energy conversion device. Is this statement correct ?

7. What is the purpose of yoke in a D.C. machine ?

8. What is critical resistance of a D.C. Shunt generator ?

9. What will happen to the speed of a D.C. motor when its flux approaches zero ?

10. Mention the effects of differential compounding and cumulatively compound on the performance of D.C. compound motor.

PART – B (5×13=65 Marks)

11. a) For the magnetic circuit shown in Fig. 11 (a), with a core thickness of 5 cm, exciting current of 0.5A wound with 1000 turns coil, find the flux density and flux in each of the outer limbs and the central limbs. Assume relative permeability for iron of the core to be a) infinity b) 4500. **(13)**

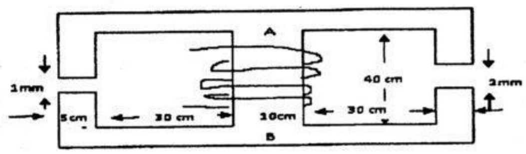


**Fig. 11 (a)**

(OR)

b) Draw and explain the typical magnetic circuit with air-gap and its equivalent electric circuit. Hence derive the expression for air gap flux. **(13)**

12. a) Explain the principle of operation of a transformer. Derive its EMF equation. **(13)**

(OR)

b) Draw and explain the phasor diagram of transformer when it is operating under load. **(13)**

13. a) The electromagnetic relay shown in Fig. 13 (a) is excited from a voltage source of $v = \sqrt{2}\ V \sin\omega t$. Assuming the reluctance of the magnetic circuit to be constant, find the expression for the average force on the armature, when the armature is held fixed at distance x. **(13)**

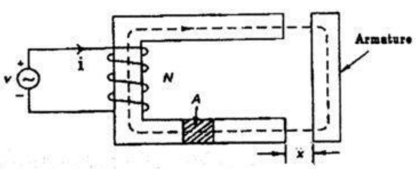


**Fig. 13 (a)**

(OR)

b) Discuss in detail the production of mechanical force for an attracted armature relay excited by an electric source. **(13)**

14. a) A separately excited generator when running at 1000 r.p.m. supplied 200A at 125 V. What will be the load current when the speed drops to 800 r.p.m. if $I_f$ is unchanged ? Given that armature resistance = 0.04 Ω and brush drop = 2 V. Derive the necessary equations. **(13)**

(OR)

b) Explain in detail about commutation and list out the various methods of improving commutation in detail with a neat sketch. **(13)**

15. a) Draw the neat sketch of 3 point starter and explain its working. **(13)**

(OR)

b) Explain the different methods of speed control of dc shunt motor with neat circuit diagrams. **(13)**

PART – C **(1×15=15 Marks)**

16. a) A 75 KVA transformer has 500 turns primary and 100 turns secondary. The primary and secondary resistances are 0.4 Ω and 0.02 Ω respectively and the corresponding leakage reactances are 1.5 Ω and 0.045 Ω respectively. The supply voltage is 2200V. Calculate a) equivalent impedance referred to the primary circuit and b) the voltage regulation and secondary terminal voltage for full load at power factor of i) 0.8 lagging and ii) 0.8 leading.

(OR)

b) A toroidal core made of mild steel has a mean diameter of 16 cm and a cross-sectional area of 3 $cm^2$. Calculate a) the m.m.f to produce a flux of $4 \times 10^{-4}$ Wb and b) the corresponding values of the reluctance of the core and the relative permeability.

Reg. No. : ____________

**Question Paper Code : 71772**

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

Fourth Semester

Electrical and Electronics Engineering

EE 6401 — ELECTRICAL MACHINES – I

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define relative permeability
2. Give the expression for hysteresis losses and eddy current losses.
3. Why transformer rating is expressed in kVA?
4. Why wattmeter in OC test on transformer reads core loss and that in SC test reads copper loss at full load?
5. Define the synchronous speed. Write the expression also.
6. Define the term pole pitch and coil pitch.
7. What is meant by armature reaction?
8. State the conditions under which a DC shunt generator fails to excite.
9. Why a starter is necessary for a DC motor?
10. What are the applications of DC motor?

PART B — (5 × 13 = 65 marks)

11. (a) Derive the expression for self inductance and mutual inductance and also define coefficient of coupling.

Or

(b) The core of an electromagnet is made of an iron rod of 1 cm diameter, bent in to a circle of mean diameter 10 cm, a radial air gap of 1 mm being left between the ends of the rod. Calculate the direct current needed in coil of 2000 turns uniformly spaced around the core to produce a magnetic flux of 0.2 mwb in the air gap. Assume that the relative permeability of the iron is 150, that the magnetic leakage factor is 1.2 and that the air gap is parallel.

12. (a) Explain the back to back method of testing for two identical single phase transformers.

Or

(b) Draw the equivalent circuit of a single phase 1100/220V transformer on which the following results were obtained.

(i) 1100V, 0.5A, 55W on primary side, secondary being open circuited

(ii) 10V, 80A, 400W on LV side, high voltage side being short circuited

Calculate the voltage regulation and efficiency for the above transformer when supplying 100 A at 0.8 pf lagging.

13. (a) Explain the concept of electromechanical energy conversion with neat diagram.

Or

(b) Explain in detailed MMF distribution in AC synchronous machine and derive the expression for fundamental MMF.

14. (a) Explain the effect of armature reaction in a DC generator. How are its demagnetizing and cross magnetizing ampere turns calculated?

Or

(b) A four pole lap wound shunt generator supplies 60 lamps of 100W, 240V each; the field and armature resistances are $55\,\Omega$ and $0.18\,\Omega$ respectively. If the brush drop is 1V for each brush find (i) Armature Current (ii) Current per path (iii) Generated emf (iv) Power output of DC machine.

15. (a) Explain the different methods of speed control techniques of DC motors.

Or

(b) With the help of neat circuit diagram, explain Swinburne's test and derive the relations for efficiency (Both for generator and Motor).

PART C — (1 × 15 = 15 marks)

16. (a) The parameters of approximate equivalent circuit of a 4KVA, 200/400V, 50Hz, single phase transformer are : $Rp^1 = 0.15$ ohm; $Xp^1 = 0.37$ohm ; $R_o = 600$ ohm; $X_m = 300$ ohm; When rated voltage of 200V is applied to the primary, a current of 10A at lagging power factor of 0.8 flows in the secondary winding. Calculate (i) the current in the primary (ii) terminal voltage at the secondary side.

Or

(b) A shunt motor runs at 600 rpm from 250V supply and takes a line current of 50A. Its armature and filed resistances are 0.4 Ω and 125 Ω respectively. Neglecting the effects of armature reaction and allowing 2V brush drop. Calculate : (i) The no-load speed if the no-load line current is 5A (ii) The percentage reduction in flux per pole in order that the speed may be 800rpm when the armature current is 40A.

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**Question Paper Code : 80373**

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

Fourth Semester

Electrical and Electronics Engineering

EE 6401 — ELECTRICAL MACHINES – I

(Regulations 2013)

Three hours — Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

What is Hysteresis Losses?

Define Flux Linkage.

Define Voltage Regulation of a transformer.

Draw Scott connection of a transformer.

What is Magnetic saturation?

What is meant by distributed winding?

Write EMF equation of D.C generator.

What is the use of Interpole in D.C machine?

List various method of starting D.C motor.

What is meant by dynamic braking in D.C motor?

PART B — (5 × 16 = 80 marks)

(a) Obtain the expression for Dynamically induced EMF and force. (16)

Or

(b) Explain the AC operation of Magnetic circuit. (16)

12. (a) The following data were obtained on a 20 kVA, 50 Hz, 2000/200 V distribution transformer:

| | Voltage (V) | Current (A) | Power (W) |
|---|---|---|---|
| OC test with HV open-circuited | 200 | 4 | 120 |
| SC test with LV short-circuited | 60 | 10 | 300 |

Draw the approximate equivalent circuit of the transformer referred to the HV and LV sides respectively. (16)

Or

(b) With circuit explain Sumpner's test and how to obtain efficiency of a transformer. (16)

13. (a) Obtain the expression for field energy and mechanical force. (16)

Or

(b) Explain about the Magnetic field in rotating machines. (16)

14. (a) Explain the construction and operation of D.C generator. (16)

Or

(b) Describe the process of commutation in D.C machine. (16)

15. (a) In a Hopkinson's test on a pair of 500-V. 100-kW shunt generators, the following data was obtained:

Auxiliary supply, 30 A at 500 V: Generator output current, 200 A Field currents, 3.5 A 1.8 A

Armature circuit resistances, 0.075 Ω each machine. Voltage drop at brushes, 2 V (each machine).

Calculate the efficiency of the machine acting as a generator. (16)

Or

(b) With a circuit, explain how to obtain efficiency of D.C Generator by conducting Swinburne's test. (16)

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

**Question Paper Code : 57316**

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

**Fourth Semester**

**Electrical and Electronics Engineering**

**EE6401 – ELECTRICAL MACHINES – I**

**(Regulations 2013)**

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

**Answer ALL questions.**

**PART – A (10 × 2 = 20 Marks)**

1. State Ampere's Law.
2. Define Leakage Flux.
3. Define all day efficiency of a transformer.
4. What is Inrush current in a transformer ?
5. Define Co-energy.
6. What is meant by winding inductance ?
7. Compare Lap and Wave windings.
8. Draw various characteristics of D.C. shunt generator.
9. Draw speed-torque characteristics of DC series motor.
10. What is meant by Plugging ?

## PART – B (5 × 16 = 80 Marks)

11. (a) Summarize the properties of magnetic materials. (16)

**OR**

(b) Explain the Hysteresis and eddy current losses and obtain its expression. (16)

12. (a) With a circuit explain how to obtain equivalent circuit by conducting O.C & S.C test in a single phase transformer. (16)

**OR**

(b) Explain the various three phase transformer connection and parallel operation of three phase transformer. (16)

13. (a) Obtain the expression for energy in a attracted armature relay magnetic system. (16)

**OR**

(b) With an example explain the Multiple-excited magnetic field system. (16)

14. (a) Explain the Armature Reaction in D.C machine. (16)

**OR**

(b) (i) Obtain EMF equation of D.C. generator. (8)

(ii) A 4-pole dc motor is lap-wound with 400 conductors. The pole-shoe is 20cm long and the average flux density over one-pole-pitch is 0.4T, the armature diameter being 30 cm. find the torque and gross-mechanical power developed when the motor is Drawing 25A and running at 1500 rpm. (8)

15. (a) The no-load test of a 44.76 kW, 220-V, D.C. shunt motor gave the following figures :

Input current = 13.25 A; Field current = 2.55 A; Resistance of the armature at 75°C = 0.032Ω and Brush drop = 2V. Estimate the full-load current and efficiency. (16)

**OR**

(b) Explain the method to obtain efficiency at full load by conducting Hopkinson's test. (16)

Reg. No. : [ | | | | | | | | | | | ]

**Question Paper Code : 21501**

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

Fourth Semester

Electrical and Electronics Engineering

EE 2251/EE 1251 A/080280003/EE 42/10133 EE 402 – ELECTRICAL MACHINES – I

(Regulations 2008/2010)

(Common to PTEE 2251/10133 EE 402 – Electrical Machines – I for B.E. (Part-Time) Third Semester – Electrical and Electronics Engineering – Regulations 2009/2010)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Name the main magnetic quantities with their symbols having the following units : Webers, Telsa, AT/Wb, H/m.

2. How will you minimize hysteresis and eddy current losses?

3. What are the no load losses in a two winding transformer and state the reasons for such losses.

4. Mention the conditions to be satisfied for parallel operation of two winding transformers.

5. What do you mean by coenergy?

6. What are the requirements of the excitation systems?

7. What is the difference between lap winding and wave winding of a DC machine armature?

8. Why does synchronous machine not produce torque at any other speed?

9. Draw the circuit model of dc shunt motor.

10. What is the function of no-volt release in a three-point starter?

PART B — (5 × 16 = 80 marks)

11. (a) Explain the statically and dynamically induced EMF. (16)

Or

(b) (i) Discuss AC operation of magnetic circuits (10)

(ii) A single phase, 50Hz, 100KVA transformer for 12000/240V ratio has a maximum flux density of 1.2 $Wb/m^2$ and an effective core section of 300 $cm^2$, the magnetising current (RMS) is 0.2A. Estimate the inductance of each wire on open circuit. (6)

12. (a) (i) Describe the construction and principle of operation of single phase transformer. (8)

(ii) Derive an expression for maximum efficiency of a transformer. (8)

Or

(b) A 500 kVA transformer has 95% efficiency at full load and also at 60% of full load both at upf.

(i) Separate out the transformer losses. (8)

(ii) Determine the transformer efficiency at 75% full load, upf. (8)

13. (a) (i) Show that the torque developed in doubly excited magnetic system is equal to the rate of increase of field energy with respect to displacement at constant current. (8)

(ii) The $\lambda - i$ characteristics of singly excited electromagnet is given by $i = 121\lambda^2 x^2$ for $0 < i < 4A$ and $0 < x < 10\,\text{cm}$. If the air gap is 5 cm and a current of 3A is flowing in the coil, calculate

(1) Field energy

(2) Co-energy

(3) Mechanical force on the moving part. (8)

Or

(b) Discuss in detail the production of mechanical force for an attracted armature relay excited by an electric source. (16)

14. (a) (i) Show the arrangement of a distributed stator winding with appropriate number of conductors in the slots designed to produce a sinusoidally varying air gap flux density. (6)

(ii) Prove that a three phase set of currents, each of equal magnitude and differing in space by 120° applied to a three phase winding spaced 120 electrical degrees apart around the surface of the machine will produce a rotating magnetic field of constant magnitude. (10)

Or

(b) (i) A D.C. machine has 'P' number of poles with curved pole faces having 'Z' number of conductors around the rotor armature of radius 'r' and the flux per pole is given as, $\varphi$ . The rotor rotates at a speed of 'n' rpm. Obtain the induced e.m.f. of the D.C. machine assuming a number of parallel paths. (8)

(ii) A 12 pole D.C. generator has a simplex wave wound armature containing 144 coils of 10 turns each. The resistance of each turn is $0.011\,\Omega$. Its flux per pole is 0.05 Wb and it is running at a speed of 200 rpm. Obtain the induced armature voltage and the effective armature resistance. (8)

15. (a) (i) A 220 V dc generator supplies 4 kW at a terminal voltage of 220 V. the armature resistance being $0.4\ \Omega$. If the machine is now operated as a motor at the same terminal voltage with the same armature current, calculate the ratio of generator speed to motor speed. Assume that the flux/pole is made to increase by 10% as the operation is changed over from generator to motor. (6)

(ii) A 220 V, 7.5 kW series motor is mechanically coupled to a fan. When running at 400 rpm the motor draws 30 A from the mains (220 V). The torque required by the fan is proportional to the square of speed. $R_a = 0.6\ \Omega$, $R_{se} = 0.4\ \Omega$. Neglect armature reaction and rotational loss. Also assume the magnetization characteristic of the motor to be linear.

(1) Determine the power delivered to the fan and torque developed by the motor. (5)

(2) Calculate the external resistance to be added in series to the armature circuit to reduce the fan speed to 200 rpm. (5)

Or

(b) A 250-V dc shunt motor has $R_f = 150\Omega$ and $R_a = 0.6\Omega$. The motor operates on no-load with a full field flux at its base speed of 1000 rpm with $I_a = 5$ A. If the machine drives a load requiring a torque of 100 Nm, calculate armature current and speed of motor. If the motor is required to develop 10 kW at 1200 rpm, what is the required value of the external series resistance in the field circuit? Assume linear magnetization. Neglect saturation and armature reaction. (16)