# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Diploma Engineering**

**Level: Diploma**

**Branch: Power Electronics Engineering**

**Subject Code: DI04024021**

**Subject Name: AC Rotating Machines**

| | |
|---|---|
| **w. e. f. Academic Year:** | 2025-26 |
| **Semester:** | 4th |
| **Category of the Course:** | PCC |

| | |
|---|---|
| **Prerequisite:** | Fundamentals of Electrical Engineering, knowledge of Measuring Instruments. |
| **Rationale:** | This course builds industry-ready skills by covering performance, control and maintenance of AC rotating machines including induction motors, synchronous motors and special motors used in automation and industrial electric control system. It equips students for technical employment in installation, commissioning and servicing of AC machines. |

**Course Outcome:**

After Completion of the Course, Student will able to:

| No | Course Outcomes | RBT Level |
|---|---|---|
| 01 | Evaluate performance of 1-phase Induction Motor. | R, U, A |
| 02 | Operate & control 3-phase induction motors | R, U, A |
| 03 | Operate synchronous machines efficiently | R, U, A |
| 04 | Select special machines based on application | R, U, A |
| 05 | Maintain & troubleshoot AC machines | R, U, A |

**Revised Bloom's Taxonomy (RBT)*

**Teaching and Examination Scheme:**

| Teaching Scheme (in Hours) | | | Total Credits L+T+ (PR/2) | Assessment Pattern and Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tutorial / Practical | | |
| L | T | PR | C | ESE (E) | PA(M) | PA(I) | ESE (V) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 20 | 30 | 150 |

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**Course Content:**

| Unit No. | Content | No. of Hours | % of Weightage |
|---|---|---|---|
| 1. | **1- Phase Induction Motor**<br>Construction, The Double-Revolving-Field Theory, Rotor Slip with Respect to Two Rotating Field.<br>Equivalent circuit: based on: Two-Revolving-Field Theory.<br>Performance calculations of a single-phase, Single-winding induction motor, power flow diagram.<br>Various test on induction machine: No load test, locked rotor test, load test, measurement of slip.<br>Types: Split-phase, Capacitor start, Capacitor run, Capacitor start–run. | 10 | 22 |
| 2. | **3-Phase Induction Motor**<br>Construction and principle of operation, Production of rotating magnetic field & slip, Torque–slip characteristics.<br>Types: Squirrel cage & Slip-ring motors.<br>Starting methods: DOL, Star-Delta, Autotransformer, Rotor resistance.<br>Speed control: Pole changing, Rotor resistance.<br>Efficiency, losses & performance testing, Cogging and crawling phenomenon in induction motors, applications. | 11 | 24 |
| 3. | **Synchronous Motors**<br>Construction, operating principle and applications.<br>Starting methods: by external prime mover, by damper windings.<br>V-curves and inverted V-curves<br>test on synchronous machine: OC test, SC test, slip test.<br>Synchronous machine: Losses & efficiency. | 10 | 22 |
| 4. | **Special Electrical Machines**<br>Stepper Motor — construction, working, types & applications.<br>Servo Motor — AC and DC types, characteristics & uses.<br>Linear Induction Motor (LIM)-construction, working, & applications.<br>Universal Motor: construction, working principle, applications.<br>Synchronous Reluctance Motor- construction, working principle, applications. | 7 | 16 |
| 5. | **Maintenance & Troubleshooting of AC Machines.**<br>Protective devices, insulation class, cooling methods.<br>Faults, causes and remedies in induction & synchronous motors.<br>Preventive and predictive maintenance. | 7 | 16 |
| | **Total** | **45** | **100** |

**Suggested Specification Table with Marks (Theory):**

| Distribution of Theory Marks (in %) | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| **30** | **60** | **10** | | | |

*Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)*

**References/Suggested Learning Resources:**

**(a) Books:**

| S. No. | Title of Book | Author | Publication with place, year and ISBN |
|---|---|---|---|
| 1 | Electric Machines | Husain Ashfaq, Harroon Ashfaq | Dhanpat Rai & Co. 2016 ISBN: 978-8177001662 |
| 2 | Electric Machinery fundamentals | Stephen J. Chapman | McGraw Hill Education,2012 ISBN 9780073529547 |
| 3 | Electrical Machines | Nagrath I. J. & Kothari D. P | McGraw Hill Education,2010 ISBN 978-0070699670 |
| 4 | Electric motor Maintenance and Troubleshooting. | Augie Hand | McGraw Hill Education, 2011 ISBN: 978-0071763950 |
| 5 | Testing Commissioning Operation & Maintenance of Electrical Equipments | Rao S. | Khanna Publishers,2021 ISBN: 9788174091857 |

**(b) Open-source software and website:**

- https://www.vlab.co.in
- https://nptel.ac.in
- https://swayam.gov.in/
- https://shodhganga.inflibnet.ac.in/
- https://onlinecourses.nptel.ac.in/

**Suggested Course Practical List:**

| S. No. | Practical |
|---|---|
| 1. | Identify the parts of the various single-phase induction motors. |
| 2. | Identify the parts of the 3-phase squirrel cage and wound rotor induction motor |
| 3. | Perform voltage ratio test on three phase induction motor. |
| 4. | Test the performance of Stepper motor. |
| 5. | Test the performance of universal motor. |
| 6. | Study of (Manual and Semi-automatic) Auto transformer starter and rotor resistance starter connection and running a 3-phase induction motor and measurement of starting current. |
| 7. | Study and Practice of connection & reverse the direction of rotation of Three Phase Induction motor. |
| 8. | Study and Practice of connection & reverse the direction of rotation of Single-Phase Induction motor |
| 9. | Perform No load and blocked rotor test on a 3- ϕ induction motor |
| 10. | To Perform load test on 3-phase ac slip ring induction motor |
| 11. | Conduct load test on the given 1 phase induction motor and to determine and plot its performance characteristics. |
| 12. | Determine the eq. circuit parameters of a 1 phase induction motor by performing the no- load and blocked rotor tests. |
| 13. | Plot the ‘v’ and ‘inverted v’ curves of Synchronous motor. |
| 14. | To determine Xd and Xq by conducting a slip test on a salient pole synchronous machine. |
| 15. | Perform beak test on three phase induction motor. |
| 16. | Perform Speed Control of 3 Phase Slip-Ring Induction Motor By Rotor Resistance Control |

**List of Laboratory/Learning Resources Required:**

| S. No. | Equipment Name with Broad Specifications |
|---|---|
| 1 | AC Motors with Mechanical Load Arrangement<br>Type: 1 Phase induction motor. |
| 2 | Three Phase AC Motors with Mechanical Load<br>Type : Three Phase Slip-Ring / Synchronous / Squirrel Cage Type |
| 3 | Variac (Variable Auto Transformers)<br>230 V, 20A |
| 4 | Starter (DOL)<br>Rheostat SPST switch |

| S. No. | Equipment Name with Broad Specifications |
|---|---|
| 5 | Work Bench for Synchronous Motor 3HP Supplied with 3 Phase Synchronous Motor 3HP, DC source for excitation with Control Panel fitted with Necessary Meters & DOL Starter |
| 6 | Speed Control of 3 Phase Slip-Ring Induction Motor by Rotor Resistance Control test kit |
| 7 | Start & Reverse the Direction of a 3 Phase Induction Motor kit: Control Panel To |
| 8 | Cut section of Stepper Motor, Servo Motor, Linear Induction Motor (LIM), Universal Motor and Synchronous Reluctance Motor. |

**Suggested Project List:**

- Make a Presentation for characteristics of various AC motors.
- Design at least one testing circuit/procedure for induction machine.
- Design at least one testing circuit/procedure for synchronous machine

**Suggested Activities for Students:**

- Make a chart of Special electric machine along with its applications.
- Interpret the various parameters by reading Name plate of AC motor.
- Make a chart of classes of insulating materials used in Electric motor.
- Make a chart of comparisons of Induction and Synchronous motor.

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