# SARVAJANIK UNIVERSITY
## Sarvajanik College of Engineering and Technology
**Bachelor of Technology**

**B.Tech. – I Year Semester I**

**Subject Name:Electrical Machine -I** **Subject Code: BTEL13182**

**Type of course: Professional Core Course**

**Prerequisite: Basic Electrical Engineering**

**Rationale:**

**Teaching and Examination Scheme:**

| TEACHING SCHEME | | | | Theory Marks | | Practical Marks | | Total |
|---|---|---|---|---|---|---|---|---|
| L | T | P | C | TEE | CAT | TEP | CAP | |
| 4 | 0 | 2 | 5 | 60 | 40 | 30 | 20 | 150 |

**CAT:** Continuous Assessment (assignments/projects/open book tests/closed book tests **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CAP:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

**Content:**

| Sr. No. | Topics | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| 1. | **DIRECT CURRENT MACHINES**<br>Construction and working principle of a DC machine, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, Commutation, Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.<br>Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt, series and compound. Open circuit characteristic of separately excited DC generator, voltage build-up in a shunt generator, critical field resistance and critical speed, V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. | **14** | **25%** |
| 2. | Starting, speed control and braking of dc machines, degree of protection, degree of cooling with ip-ic code and enclosures of rotating machines, Starting of DC motors, necessity and types of starters, Schematic diagrams of control circuit and power circuit for starters with contactors and timers. design of starters, | **11** | **10%** |

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| | | | |
|---|---|---|---|
| | Methods of Speed control, Methods of braking, Degree of protection, cooling system, degree of cooling with IP- IC code (brief discussion), enclosures of rotating machines | | |
| **3.** | **TESTING OF DC MACHINES**<br>Losses and Efficiency in DC machines, power flow diagram, Swinburne's test, Hopkinson's test, Field test, Retardation test, Separation of losses of a DC shunt machine. | **5** | **10%** |
| **4.** | **TRANSFORMERS**<br>Construction and working principle of single-phase transformers, equivalent circuit, phasor diagram, open circuit and short circuit tests, voltage regulation, losses and efficiency, magnetic inrush and effect of saturation, parallel operation, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current,<br>**Autotransformers** : Construction, principle, applications and comparison with two winding transformer, Phase conversion | **14** | **25%** |
| **5.** | **POLYPHASE TRANSFORMERS**<br>Construction, types of connection and their comparative features, Vector groups, Parallel operation of three-phase transformers, open delta connection, Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers. | **8** | **15%** |
| **6.** | **TESTS ON TRANSFORMERS**<br>Polarity test, back-to-back test, separation of hysteresis and eddy current losses, Type, Routine and Special Tests of transformers | **8** | **10%** |

**Suggested Specification table with Marks (Theory/Practical):**

| **% Distribution of Marks** | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| **30** | **30** | **20** | **10** | **10** | **00** |

**Legends: R:** Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels **(Revised Bloom's Taxonomy)**

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**PCC: Professional Core Course**

**Reference Text Books:**

| Sr. No. | Title of book /article | Author(s) | Publisher and details like ISBN | Year of publication | Publication Edition |
|---|---|---|---|---|---|
| 1 | Electric Machines | I J Nagrath and Kothari | McGraw Hill Education | 2010 | |
| 2 | Theory and Performance of Electrical Machines | J B Gupta | Katson Publication | 2009 | |
| 3 | Electrical Technology – Part II | B L Theraja | S Chand Publications | 2011 | |
| 4 | Electrical Machinery | P. S. Bimbhra | Khanna Publishers | 2011 | |
| 5 | Performance and design of AC machines | M. G. Say | CBS Publishers | 2002 | |
| 6 | Electric Machinery | E. Fitzgerald and C. Kingsley | New York, McGraw Hill Education | 2013 | |
| 7 | Performance and design of DC machines | A E Clayton and N. N. Hancock | CBS Publishers | 2004 | |

**Course Outcome:**

| Sr. No. | CO Statement<br>After learning this subject, students will be able to | Marks % weightage |
|---|---|---|
| **CO-1** | Describe working principle, performance, control and applications of DC Machines and transformer | 30 |
| **CO-2** | Demonstrate, analyze and conduct various tests on DC machine and transformer | 25 |
| **CO-3** | Identify, formulate, analyze and solve DC machine and transformer related problems. | 30 |
| **CO-4** | Identify applications of various DC machines and transformer | 15 |

**Mapping with POs:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-1** | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | | | 1 |
| **CO-2** | 3 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 2 | | | 1 |
| **CO-3** | 1 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO-4** | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | | 1 | 1 |

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**LIST OF PRACTICALS**: (Minimum 10 to be performed)

1. To obtain Magnetizing Characteristics, Internal & External Characteristic of Self Excited DC Shunt Generator. Also obtain the critical field resistance of the machine from magnetizing Characteristics.
2. To obtain Speed-Torque characteristics of DC Series Motor and DC Shunt Motor.
3. To perform filed test on D.C. series motor.
4. To perform direct load test on a D.C. shunt motor and plot variation of (a) Input current (b) Speed(c) Torque (d) Efficiency versus output power.
5. Speed control of DC Shunt Motor using a) Armature control and b) field control methods. Also perform Swinburne's test on DC Shunt Motor.
6. To determine the efficiency of two similar shunt machines by regenerative method. (Hopkinson's Test.)
7. To determine the various losses in a D.C. machine and separation of its core losses.
8. To conduct open circuit and short circuit test on a single phase and three phase transformer and determine the equivalent circuit parameters.
9. To operate two single phase transformers of different kVA ratings in parallel and plot the variation of currents shared by each transformer versus load current.
10. To conduct Sumpner test on two identical single phase transformers and determine their efficiency at various loads.
11. To make Scott connection of two single phase transformer and to verify the three phase to two phase conversion.
12. To separate hysteresis and eddy current losses of a single phase transformer at rated voltage, frequency by conducting no load tests at different frequencies keeping V/f constant.

**Major Equipment:**

Ammeters, Voltmeters, Wattmeters, Multi-meters, DC Shunt Machines, DC Series Machines Single-phase and Three-Phase Transformers, Charts for earthling and safety precautions

**List of Open Source/learning website:**

- https://nptel.ac.in/courses/108/105/108105053/
- https://nptel.ac.in/courses/108/108/108108076/
- https://nptel.ac.in/courses/108/102/108102146/
- https://nptel.ac.in/courses/108/105/108105131/
- https://nptel.ac.in/courses/108/105/108105155/